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Proposed Re-evaluation Decision PRVD2016-01

# Acephate

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# Overview

## What is the proposed Re-evaluation Decision?

After a re-evaluation of the organophosphate insecticide acephate, Health Canada's Pest Management Regulatory Agency (PMRA), under the authority of the *Pest Control Products Act*, is proposing continued registration of certain products containing acephate for the sale and use in Canada.

An evaluation of available scientific information found that, under the proposed conditions of use:

- Most uses of acephate have value in the food and non-food agriculture industry and are not of concern to human health or the environment when used according to revised label directions. As a requirement of the continued registration for these uses, new risk-reduction measures are proposed to be included on the labels of certain products.
- Based on potential health concerns, the PMRA is proposing to cancel the registration of the end-use product formulated as a soluble powder.
- A pellet formulation was determined to be an acceptable alternative to the soluble powder formulation for most uses, which would require registration for the pellet formulation.
- Certain Maximum Residue Limits (MRLs) for acephate and methamidophos, the primary metabolite of acephate, are proposed to be revoked or revised due to potential health risk concerns and the proposed changes to the registration status of acephate and methamidophos products in Canada and the United States.

Health Canada's pesticide re-evaluation program considers potential risks as well as the value of pesticide products to ensure they meet modern standards established to protect human health and the environment. Regulatory Directive DIR2001-03, *PMRA Re-evaluation Program*, presents the details of the re-evaluation activities and program structure. Re-evaluation draws on data from registrants, published scientific reports, information from other regulatory agencies and any other relevant information available.

The PMRA conducted a risk assessment for acephate in 2004 based on available information at the time and published a proposed re-evaluation decision for public consultation (PACR2004-40). Methamidophos, the primary metabolite of acephate, was not fully considered in the acephate risk assessment since a concurrent risk assessment for methamidophos as a registered active ingredient at the time was being conducted.

Pending the completion of the risk assessment for methamidophos, the PMRA implemented interim mitigation measures for acephate products in 2007 (REV2007-02). While formulating these measures, the PMRA considered the measures proposed in PACR2004-40, the comments received on PACR2004-40, as well as the additional data and use information from the registrant.

Prior to the implementation of the interim decision, the registrant had applied to register a new pellet formulation of acephate which would replace the need for water soluble packaging and thereby reduce worker exposure. The pellet formulation has since been registered for use on tobacco only.

The PMRA completed a preliminary risk assessment for methamidophos in 2007 (REV2007-11), and identified potential risks to the environment, to workers during application and postapplication activities, as well as to the general population through food and drinking water exposure. Subsequently, the technical registrants of methamidophos voluntarily discontinued all methamidophos products and the registrations expired in 2012. Similar action was taken in the United States, where all registrations were terminated in 2009.

Since the 2007 interim mitigation measures for acephate, the PMRA has updated the risk assessments considering new data, inclusion of methamidophos in the risk assessments, and the pellet formulation as a potential replacement of the soluble powder formulation. All updates are discussed in this document.

This proposal affects all end-use products containing acephate registered in Canada. Once the final re-evaluation decision is made, the registrants will be instructed on how to address any new requirements.

This Proposed Re-evaluation Decision is a consultation document[1] that summarizes the science evaluation for acephate and presents the reasons for the proposed re-evaluation decision. It also proposes additional risk-reduction measures to further protect human health and the environment.

The information is presented in two parts. The Overview describes the regulatory process and key points of the evaluation, while the Science Evaluation provides detailed technical information on the assessment of acephate.

The PMRA will accept written comments on this proposal up to 60 days from the date of publication of this document. Please forward all comments to Publications (please see contact information indicated on the cover page of this document).

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[1] "Consultation statement" as required by subsection 28(2) of the *Pest Control Products Act*.

## What Does Health Canada Consider When Making a Re-evaluation Decision?

The key objective of the *Pest Control Products Act* is to prevent unacceptable risks to people and the environment from the use of pest control products. Health or environmental risk is considered acceptable[2] if there is reasonable certainty that no harm to human health, future generations or the environment will result from use of or exposure to the product under its conditions or proposed conditions of registration. The Act also requires that products have value[3] when used according to the label directions. Conditions of registration may include special precautionary measures on the product label to further reduce risk.

To reach its decisions, the PMRA applies hazard and risk assessment methods as well as policies that are rigorous and modern. These methods consider the unique characteristics of sensitive subpopulations in both humans (for example, children) and organisms in the environment (for example, those most sensitive to environmental contaminants). These methods and policies also consider the nature of the effects observed and the uncertainties present when predicting the impact of pesticides. For more information, please refer to the following:

- Protecting Your Health and the Environment
- Pesticide Registration Process
- Pesticide Risk Reduction Program

Before making a re-evaluation decision on acephate, the PMRA will consider any comments received from the public in response to this consultation document. The PMRA will then publish a Re-evaluation Decision on acephate, which will include the decision, the reasons for it, a summary of comments received on the proposed registration decision and the PMRA's response to these comments.

For more details on the information presented in this overview, please refer to the Science Evaluation of this consultation document.

## What is Acephate

Acephate is an organophosphate insecticide used to control a broad range of insect pests on a wide variety of sites including forests and woodlots (Christmas tree plantations, farm woodlots, tree nurseries, shelter belts, shade trees), right of ways and municipal parks (excluding national & provincial parks), greenhouse ornamentals, terrestrial food and feed crops (Brussels sprouts, cabbage, cauliflower, celery, field crisphead lettuce, seed and sweet corn, bell pepper, potato, field tomato, cranberry, tobacco, Saskatoon berry) and outdoor ornamentals (numerous flowers, shrubs and trees). Acephate is applied using conventional ground application equipment, soil injection, tree trunk injection and implant cartridges by farmers, farm workers and professional applicators.

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[2] "Acceptable risks" as defined by subsection 2(2) of the *Pest Control Products Act*.

[3] "Value" as defined by subsection 2(1) of the *Pest Control Products Act*: "… the product's actual or potential contribution to pest management, taking into account its conditions or proposed conditions of registration, and includes the product's (*a*) efficacy; (*b*) effect on host organisms in connection with which it is intended to be used; and (*c*) health, safety and environmental benefits and social and economic impact".

## Health Considerations

### Can Approved Uses of Acephate Affect Human Health?

**Acephate is unlikely to affect your health when used according to revised label directions.**

Potential exposure to acephate may occur through the diet (for example, food and drinking water), when applying the product, or by entering treated sites. When assessing health risks, two key factors are considered: the levels at which no health effects occur and the levels to which people may be exposed. The dose levels used to assess risks are established to protect the most sensitive human population (for example, children and nursing mothers). Only uses for which the exposure is well below levels that cause no effects in animal testing are considered acceptable for registration.

Toxicology studies in laboratory animals describe potential health effects from varying levels of exposure to a chemical and identify the dose at which no effects are observed. The health effects noted in animals occur at doses more than 100-times higher (and often much higher) than levels to which humans are normally exposed when pesticide products are used according to revised label directions.

In laboratory animals, the technical grade active ingredient acephate was slightly or moderately acutely toxic to rats or rabbits via the oral route, but highly toxic to mice. It was of low acute toxicity via the dermal and inhalation routes of exposure. Acephate was mildly irritating to eyes and skin and was not found to cause an allergic skin reaction.

Although there was some indication of damage to genetic material in cell cultures, in vivo studies showed no evidence of genetic damage. Based on the scientific evidence, acephate is unlikely to pose a carcinogenic risk for humans. Acephate did not cause birth defects in animals and adverse reproductive outcomes were only noted following exposure to high levels. The developing fetus and the juvenile animal did not appear to be more sensitive than the adult animal to the effects of acephate. Animals given single doses of acephate exhibited effects on the nervous system (decreased cholinesterase activity), while animals given repeat doses of acephate demonstrated effects on the liver. The available studies did not indicate a concern for an effect on the immune system.

The risk assessment with revised mitigation measures protects against the effects of acephate by ensuring that the level of human exposure is well below the lowest dose at which these effects occurred in animal tests.

### Residues in Drinking Water and Food

**Dietary risks from food and drinking water are not of concern provided that proposed mitigation measures are implemented.**

Reference doses define levels to which an individual can be exposed over a single day (acute) or lifetime (chronic) and expect no adverse health effects. Generally, dietary exposure from food and water is not of concern if it is less than 100% of the acute reference dose or chronic reference dose (acceptable daily intake). An acceptable daily intake is an estimate of the level of daily exposure to a pesticide residue that, over a lifetime, is believed to have no significant harmful effects.

In the environment, acephate is metabolized to or degrades to methamidophos. As a result, methamidophos may be formed in food and drinking water as a result of acephate use. Thus, dietary exposure and risk assessments were conducted for both acephate and methamidophos.

Human exposure to acephate and methamidophos was estimated from residues in treated crops and drinking water, including the most highly exposed population subgroups (for example, infants < 1 years, children 1-2 years). Residue estimates in food were mostly based on monitoring data from the USDA (United States Department of Agriculture) Pesticide Data Program as well as the CFIA (Canadian Food Inspection Agency) National Chemical Residue Monitoring Program. Residues in drinking water were based on modelling data.

The estimated acute exposure for acephate and methamidophos in food and drinking water was of concern based on initial modelled drinking water concentrations. The estimated acute exposure ranged from 600-2900% of the acute reference dose (ARfD) for acephate and 1100-5400% of the ARfD for methamidophos for the various population subgroups. Due to the risk concerns identified, mitigation measures and refinements were considered in the modelled drinking water concentrations. The mitigation measures considered included the removal of acephate use on potatoes, the reduction of application rates and number of applications per season, as well as increasing minimum application intervals for several crop uses. Details on these considerations are noted in Section 3.4.1 of this document. With refined modelled drinking water concentrations, the estimated acute exposure ranged from 23-49% of the ARfD for acephate and 33-56% of the ARfD for methamidophos for the various population subgroups. Therefore, acute exposure from acephate and methamidophos in food and drinking water are not of concern provided that the mitigation measures outlined in Section 3.4.1 are implemented.

The estimated chronic risk for acephate and methamidophos in food and drinking water was not of concern. Based on initial modelled drinking water concentrations, the estimated chronic exposure ranged from 8-36% of the acceptable daily intake (ADI) for acephate and 16-69% of the ADI for methamidophos for the various population subgroups. With refined modelled drinking water concentrations, the estimated chronic exposure ranged from 1-3% of the ADI for acephate and 1-2% of the ADI for methamidophos for the various population subgroups.

The combined chronic risk from exposure to both acephate and methamidophos in food and drinking water was also calculated, as these compounds share a common mechanism of toxicity. The aggregate risk index (ARI) based on initial water modelled concentrations was greater than 2 in all populations subgroups except infants, where the ARI was 0.9. With refined modelled drinking water concentrations and in consideration of mitigation measures and refinements as discussed above, the ARI was greater than 20 for infants and all other population subgroups. An ARI of 1 or greater indicates that exposure to both compounds is not of concern.

The combined acute risk could not be determined for acephate and methamidophos due to constraints in comparing the toxicological databases of both compounds. Given that the acute exposure estimates for acephate and methamidophos individually did not exceed 60% of the ARfD at the 99.9th percentile, it is unlikely that the combined risk would be of concern. The PMRA will assess the combined risks of organophosphate pesticides once all individual organophosphates have been re-evaluated. This cumulative risk assessment will consider potential exposure to all organophosphate pesticides causing toxicity in the same manner.

The *Food and Drugs Act* prohibits the sale of adulterated food, which includes food containing a pesticide residue that exceeds the established maximum residue limit (MRL). Pesticide MRLs are established through the evaluation of scientific data under the *Pest Control Products Act*. Each MRL value defines the maximum concentration in parts per million (ppm) of a pesticide allowed in/on certain foods. Food containing a pesticide residue that does not exceed the established MRL does not pose an unacceptable health risk.

MRLs are specified for acephate and methamidophos on a wide range of commodities. Where no specific MRL has been established, a default MRL of 0.1 ppm applies, which means that pesticide residues in a food commodity must not exceed 0.1 ppm. The current MRLs for acephate and methamidophos are listed in Section 9.1.1.3.

Several MRL changes for acephate and methamidophos are proposed as a result of this re-evaluation, as indicated in Section 9.1.1.3. The changes to the MRLs are proposed to account for the phase-out of all methamidophos uses, to reflect the current registered use pattern for acephate, to account for proposed mitigation measures, and to ensure that residues in food do not pose any health risk concerns.

### Risks in Residential and Other Non-Occupational Environments

**Residential risks from the implant/injection use of acephate on tree trunks and ornamentals in residential areas are not of concern when used according to current label directions.**

**Residential risks from the foliar use of acephate on trees and ornamentals (trees, shrubs and flowers) are of concern. Risk mitigation is required for this use.**

Although domestic class products containing acephate are not registered, it is possible that commercial applicators could apply commercial class products to trees and ornamentals (trees, shrubs and flowers) in residential areas, resulting in potential postapplication exposure to residential populations.

Treatment to trees and ornamentals using implant cartridges, and various methods of tree trunk injection resulting in no contact with the foliage is expected to result in minimum exposure to residential populations such as children and gardeners. Therefore, risks of concern were not identified with this use.

For foliar applications to trees and ornamentals in residential areas, quantitative estimates of exposure and risk were determined for both acephate and methimidophos based on the available data, or using standard defaults in the absence of data. Estimates of exposure did not reach the target margin of exposure (MOE) or aggregate risk index (ARI) for adults and children for all postapplication scenarios and are, therefore, of concern. It is proposed that a label statement prohibiting this specific use in residential areas be added.

### Occupational Risks from Handling Acephate

**Occupational (mixer/loader/applicator) risks are not of concern when products are used according to revised label directions and/or products are formulated as a pellet and encapsulated tree implant.**

For tree implant cartridges, exposure and risk were not of concern when used as per label directions, since applicator exposure was minimal. No mitigation is required.

Currently, the main product available for foliar applications in various agricultural and horticultural scenarios is packaged as a soluble powder. When using this formulation, target MOEs were not achieved for most scenarios based on current label directions for various application equipment. Target MOEs were achieved only when using extensive mitigation such as full personal protective equipment (PPE), engineering controls, lowered rates or removal of specific uses.

During the comment period for PACR2004-40, the registrant indicated that a pellet formulation would be an alternative to a closed system for the soluble powder formulation. As a result, a risk assessment for the pellet formulation was also conducted for all foliar, soil injection and some tree injection application scenarios currently registered on the label of the soluble powder product. When using the pellet formulation with the various application equipment, the calculated MOEs meet the target MOE with minimal mitigation, such as baseline PPE for most crops and a respirator for a few specific uses.

No data was available to assess handler exposure from hand-held mist blowers for mist application in greenhouses. In the absence of data to estimate risk, label directions specifying "Not for use with hand-held mist blowers" and "Automated mist blowers are permitted" are required. These label directions can be removed if data are submitted to estimate exposure and demonstrate no risks of concern.

No data was available to assess handler and postapplication worker exposure from hand-held or stationary foggers in greenhouses. In the absence of data to estimate risk, a label direction specifying "Not for use with fogging equipment" is required. This label direction can be removed if data are submitted to estimate exposure and demonstrate no risks of concern.

**Occupational postapplication risks are not of concern based on revised label directions. Most proposed REIs are agronomically feasible.**

Postapplication occupational risk assessments consider exposure to workers entering treated sites in agriculture and other scenarios. Occupational postapplication risks are not of concern if proposed protective measures are followed. Based on the precautions and directions for use on the current product labels, some postapplication risks to workers performing activities such as thinning, pruning and harvesting of crops, did not meet current standards and are of concern. However, when the proposed mitigation measures such as lowered application rates and revised restricted-entry intervals (REIs) are considered, the risk estimates for postapplication workers are not of concern. Proposed REIs range from 12 hours to 20 days. Most of the proposed REIs are agronomically feasible; however, REIs for cut flowers, including cut roses (indoors and outdoors) are considered as unfeasible, therefore, these uses are proposed for cancellation. The PMRA is requesting feedback on the use pattern for these uses.

Proposed protective measures to reduce worker exposure require consultation with user groups to determine their acceptability. Although the postapplication risk assessment for the horticultural scenarios identified risks of concern based on the current use pattern, the risk estimates include a number of uncertainties. The generation of additional data may refine the current risk assessment and may potentially reduce the proposed REIs.

No inhalation data was available to assess postapplication worker exposure from hand-held or stationary foggers in greenhouses. In the absence of data to estimate risk, a label direction specifying "Not for use with fogging equipment" is required. This label direction can be removed if data are submitted to estimate exposure and demonstrate no risks of concern.

## Environmental Considerations

### What Happens When Acephate Is Introduced Into the Environment?

**When used according to the revised label directions, acephate does not pose an unacceptable risk to the environment.**

Acephate can enter nontarget terrestrial and aquatic habitats through spray drift and can enter aquatic habitats through runoff and leaching. Acephate and its major transformation product, methamidophos, break down quickly in soil and water and are not expected to persist in the environment. Acephate and methamidophos are soluble in water and mobile in soil. Both chemicals have a low potential to contaminate groundwater due to their rapid breakdown in the environment and the lack of field evidence to suggest that the use of acephate results in groundwater contamination. The transformation product methamidophos was included in the risk assessment as it can be more toxic to nontarget organisms than acephate.

Under controlled laboratory conditions, acephate and methamidophos can be toxic to some nontarget species such as bees, beneficial insects, birds, wild mammals, aquatic invertebrates, amphibians and fish. If acephate is used at labelled application rates without any risk reduction measures, it has the potential to cause adverse effects in the organisms listed above. Therefore, mitigation measures are required in order to reduce potential exposure of nontarget organisms and reduce environmental risks. When acephate is used in accordance with the revised label, the resulting environmental risk posed by acephate and methamidophos is considered to be acceptable.

## Value Considerations

### What is the Value of Acephate?

**Acephate contributes to pest management in Canadian food crops.**

Acephate is registered to control a broad spectrum of insect pests on a wide variety of crops and contributes to pest management by offering an alternative mode of action for use on Canadian food crops. In addition, for some uses of acephate, there are limited alternative active ingredients, or few other pest management options for the purpose of managing insecticide resistance. There are no alternative active ingredients to acephate registered in Canada to control root maggots, wireworm on tomato; and rose midge on greenhouse grown roses. Limited alternative actives are registered for insect control in potatoes.

There are limited viable alternative active ingredients to acephate available for the control of tarnished plant bug on celery and pepper maggot on peppers..

Acephate also is important to the management of resistance to other active ingredients registered for the control of woolly apple aphid and woolly elm aphid on Saskatoon berry and omnivorous leaf roller on greenhouse roses.

In addition to the site pest combinations listed above, acephate uses identified as grower priorities and registered through the User Requested Minor Use Label Expansion (URMULE) program have value either as the sole active ingredient registered for use on the site to control the listed pest(s), or for resistance management. Crops with minor use registrations identified as having particular value are the following: aphids on celery; blackheaded fireworm on cranberry; and the pipette and syringe application method to trees for the control of sucking and chewing insects.

**Acephate contributes to pest management in the ornamental industry.**

Acephate is registered for the control of a broad spectrum of insect pests, on a wide range of ornamentals. This is of particular value to producers of ornamental crops as they typically grow a wide variety of plants which require protection from pests that are often uncommon or sporadic in nature. Frequently, few alternative active ingredients are registered in Canada to control these pests.

Acephate is registered for application to a wide variety of trees using several application methods. Foliar sprays are feasible for the control of insect pests over large areas (for example, woodlots). The cartridge implant and trunk injection application methods are of value for insect control on high value trees where applications of foliar sprays are not feasible such as in urban areas, or trees close to ecologically sensitive habitats. Additionally, cartridge implants provide protection to trees for a period of 10 to 12 weeks for heavy infestations and up to 18 weeks for light infestations, replacing the need for several foliar applications.

**Use of acephate may avoid repeated applications of non-systemic and contact insecticides.**

Acephate is a systemic insecticide with long lasting residual activity (typically 10 to 21 days), which is absorbed and transported throughout the plant, thereby protecting the whole plant. Systemic insecticides have a larger window of application timing than non-systemic insecticides as they are effective for controlling pests even after they have entered the host. Active ingredients with prolonged residual activity are of particular benefit to growers when insect pests emerge over extended periods of time such as due to cool weather, or when insect pest populations remain at economically damaging levels for long periods due to overlapping generations.

## Measures to Minimize Risk

Registered pesticide product labels include specific instructions for use. Directions include risk reduction measures to protect human and environmental health. These directions must be followed by law. As a result of the re-evaluation of acephate, the PMRA is proposing further risk reduction measures for product labels.

## Key Risk-Reduction Measures

### Human Health

- To protect mixer/loaders/applicators: replacement of the soluble powder formulation with the pellet formulation, and inclusion of label restrictions that the product is not to be applied by a handheld mist blower or a fogger
- To protect workers entering treated sites: agronomically feasible restricted-entry intervals (REIs) are proposed; those uses with non-agronomically feasible REIs (for example, outdoor cut flowers and greenhouse cut flowers) are proposed for cancellation.
- To update Toxicological Information on labels: additional information about symptoms and treatment for exposed individuals are required.
- Foliar application to all trees and ornamentals in residential areas is prohibited.
- Use on potatoes is proposed for cancellation.
- To reduce food and drinking water risk concerns: application rate and maximum number of applications per year are proposed to be reduced, and minimum application intervals are proposed to be increased for certain crops.

### Environment

- Changes to label statements, including precautionary statements and buffer zones for nontarget aquatic habitats are required as a result of the environmental risk assessment.
- Changes to label statements to include precautionary statements for sites with characteristics that may be conducive to runoff and when heavy rain is forecasted are required to reduce the potential for acephate in runoff to adjacent aquatic habitats.
- Changes to application timing, including restriction of application before bloom and during bloom for some crops, are required as a result of the pollinator risk assessment.

## What Additional Scientific Information is Being Requested?

There are no additional data required under section 12 of the *Pest Control Products Act*.

## Next Steps

Before making a final re-evaluation decision on acephate, the PMRA will consider any comments received from the public in response to this consultation document. A science-based approach will be applied in making a final decision on acephate. The PMRA will then publish a Re-evaluation Decision[4] that will include the decision, the reasons for it, a summary of comments received on the proposed decision and the PMRA's response to these comments.

Once all organophosphate pesticides have been re-evaluated, a cumulative risk assessment will be conducted that will consider potential exposure to all chemicals causing toxicity in the same manner.

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[4] "Decision statement" as required by subsection 28(5) of the *Pest Control Products Act*.

## Other Information

At the time that the re-evaluation decision is made, the PMRA will publish an Evaluation Report on acephate in the context of this re-evalulation decision (based on the Science Evaluation of this consultation document). In addition, the test data on which the decision is based will also be available for public inspection, upon application, in the PMRA's Reading Room (located in Ottawa).

# Science Evaluation

## 1.0 Introduction

Acephate is a broad spectrum systemic organophosphate insecticide belonging to the insecticide resistance management Mode of Action (MoA) Group 1B, which inhibits the acetylcholinesterase enzyme. It works by contact and ingestion action. Acephate is applied using conventional ground application equipment, soil injection, tree trunk injection and implant cartridges by farmers, farm workers, and professional applicators. Acephate has long lasting residual activity (10 to 21 days) as it metabolizes into methamidophos, another molecule with insecticidal properties.

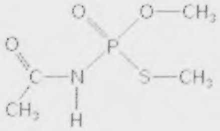
Arysta LifeScience Corporation, the registrant of the technical grade active ingredients (TGAI) and primary data provider in Canada, indicated that it intends to support all uses included on the labels of Commercial Class end-use products (EPs).

## 2.0 The Technical Grade Active Ingredients, their Properties and Uses

### 2.1 Identity of the Technical Grade Active Ingredient.

| | | |
|---|---|---|
| **Common name** | | Acephate |
| **Function** | | Insecticide and Acaricide |
| **Chemical Family** | | Organophosphate |
| **Chemical name** | | |
| 1 | **International Union of Pure and Applied Chemistry (IUPAC)** | (*RS*)-(*O*,*S*-dimethyl acetylphosphoramidothioate)<br>or<br>(*RS*)-*N*-[methoxy(methylthio)phosphinoyl]acetamide |
| 2 | **Chemical Abstracts Service (CAS)** | *O*,*S*-dimethyl acetylphosphoramidothioate |
| **CAS Registry Number** | | 30560-19-1 |
| **Molecular Formula** | | $C_4H_{10}NO_3PS$ |

**Structural Formula**



**Molecular Weight** 183.2

| Registration Number | Purity of the Technical Grade Active Ingredient (%) |
|---|---|
| 22109 | 99.78 |
| 27917 | 98.0 |

Based on the manufacturing process used, impurities of human health or environmental concern as identified in the *Canada Gazette*, Part II, Vol. 142, No. 13, SI/2008-67 (2008-06-25), including the Toxic Substances Management Policy (TSMP) Track 1 substances, are not expected to be present in the product.

## 2.2 Physical and Chemical Properties of the Technical Grade Active Ingredient

| Property | Result |
|---|---|
| Vapour pressure at 25°C | 0.226 mPa |
| Ultraviolet (UV) / visible spectrum | Not expected to absorb at $\lambda > 300$ nm |
| Solubility in water at 20°C | 790 g/L |
| n-Octanol/water partition coefficient | $\log K_{ow} = -0.89$ |
| Dissociation constant | $pK_a = 8.35$ |

## 2.3 Description of Registered Acephate Uses

Appendix I lists all acephate products that are currently registered as of June 11, 2015, under the authority of the *Pest Control Products Act* excluding those products which are to be discontinued, or for which a submission to discontinue the product registration has been received by the PMRA. Appendix II lists all of the uses for which acephate is currently registered, excluding the uses for discontinued products or products with a submission for discontinuation.

All uses were supported by the registrant and were, therefore, considered in the health and environmental risk assessments of acephate. Also presented in Appendix II are uses that were registered through the PMRA's User Requested Minor Use Label Expansion (URMULE) program. While currently supported by the registrant, the data supporting the uses were originally generated by a user group.

Uses of acephate belong to the following use-site categories: forests and woodlots, greenhouse ornamentals, terrestrial feed crops, terrestrial food crops and outdoor ornamentals.

# 3.0 Impact on Human and Animal Health

## 3.1 Toxicology Summary - Acephate

A detailed review of the toxicological database for the technical grade active ingredient, acephate, was conducted. The database is complete and consists of the full array of toxicity studies currently required for hazard assessment purposes. The toxicology database supporting acephate is based primarily on studies available from the registrant and is considered adequate to define the majority of the toxic effects that may result from exposure to acephate.

Pharmacokinetic studies in the rat showed that radiolabelled acephate was rapidly and extensively absorbed from the gastrointestinal tract with little tendency for tissue accumulation. Radiolabel was eliminated mainly in the urine, with a small amount excreted in the feces and as expired carbon dioxide. The primary urinary metabolite was unchanged acephate. A small amount of administered acephate in rats (<2% of the administered dose) was converted to methamidophos by intestinal microorganisms. The toxicokinetic patterns did not appear to be significantly influenced by gender, dose level or duration of dosing. A metabolic pathway was not elucidated as the majority of absorbed acephate was not metabolized.

In acute oral toxicity studies, acephate was slightly or moderately toxic to rats and rabbits, but highly toxic to mice. Low acute toxicity was observed in rats via the dermal or inhalation routes. It was mildly irritating to the eyes and skin of rabbits and was not found to be a skin sensitizer in guinea pigs. Acute toxicity signs induced by acephate via the oral route are consistent with signs of cholinesterase intoxication and include tremors, salivation, ataxia, depression, bloody tears, lacrimation, decreased motor activity, loss of coordination, labored breathing and death.

Following both single and repeated dosing, the most sensitive indicator of toxicity was the inhibition of acetylcholinesterase, an enzyme necessary for the proper functioning of the nervous system. Acetylcholinesterase was affected following exposure by the oral, dermal and inhalation routes with no appreciable species or gender differences. Decreased brain cholinesterase activity was generally the most sensitive effect in animal species when tested in rats, dogs and monkeys, of which, rats and dogs were comparably sensitive based on established effect levels. *In vitro* studies of rat, monkey and human tissues indicate that brain and erythrocyte cholinesterase activity were more sensitive in the rat than in the monkey and human. Decreased body-weight gain (mice, rats, rabbits and monkey) and food consumption along with an increased incidence of clinical signs typical of the organophosphate class of chemicals (mice, rats and rabbits) were observed at higher doses. Alterations in liver weight and liver pathology were also recorded at high doses after short-term or chronic exposure in mice, rabbits and dogs. Duration of dosing (subchronic to chronic) had little effect in rats as demonstrated by the established effect levels and the markedly consistent degree of brain cholinesterase depression over time in the chronic study (weeks 7, 19 and 52 and months 22 and 28).

No pronounced sex differences with respect to toxicity were noted in the available database. No treatment-related neuropathy was evident after acute, short or long-term exposure, although neurological signs of toxicity were demonstrated. Acephate did not cause any apparent delayed neurotoxicity in hens following acute exposure.

Acephate was not genotoxic in *in vivo* germinal cell, somatic cell, chromosome aberration, sister chromatid exchange and micronucleus assays, but a positive or weakly positive response was observed in some *in vitro* assays (bacteria, yeast, cultured mammalian cells and UDS in human fibroblasts). The negative findings from the *in vivo* assays lessen the concern for a potential mutagenic hazard. No carcinogenicity was evident in a 2-year chronic toxicity and carcinogenicity study in rats. However, a 2-year mouse study showed an increase in the incidence of hepatocellular carcinomas in female mice at the highest dose tested. As this effect was confined to a single species, a single sex and a single site (liver) at a dose exceeding MTD, the evidence of carcinogenicity was considered limited.

The developmental toxicity studies in rats and rabbits showed no evidence of teratogenic effects and no additional sensitivity of the fetus following in utero exposure to acephate. Developmental effects in rats (decreased fetal weight) were observed only in the presence of maternal toxicity. A report in the literature identified additional developmental effects in mice which included decreased numbers of live fetuses and fetal weight and increased early resorptions and external or skeletal abnormalities but only at a dose level showing severe maternal toxicity. In the 3-generation reproductive toxicity study in rats, no sensitivity of the young was demonstrated at the levels tested. Decreased mating performance, litter size and pup viability were observed at the parentally toxic dose level of 25 mg/kg bw/day (NOAEL (no observed adverse effect level) of 2.5 mg/kg bw/day). In another published study, the reproductive capability of male mice was examined following repeat-dose exposure to acephate prior to mating. Exposure to repeated high doses of acephate (≥14 mg/kg bw/day) resulted in cholinergic signs of toxicity, decreased muscle and brain cholinesterase activity levels and testicular effects in the parental male mice and abnormal pregnancy outcomes in the untreated female mates. A developmental neurotoxicity study was conducted in rats and revealed a potential effect on memory of exposed male pups at a dosage level that resulted in significant inhibition of brain cholinesterase activity. This effect on memory did not demonstrate a dose-response relationship and without acceptable historical and positive controls, there was uncertainty in the interpretation of this finding.

No increased sensitivity of the fetus was evident in mice, rats or rabbits following in utero exposure to acephate; however, cholinesterase measurements were lacking in the standard developmental studies in maternal and fetal animals, which precluded a more refined analysis of the relative sensitivity of the young. Likewise, the lack of cholinesterase measurements in the reproduction assay hindered the assessment of the potential sensitivity of the juvenile animal. To address the uncertainty associated with potential sensitivity of the young, a series of comparative cholinesterase studies were conducted in various rat populations following both acute and repeat-dose exposure. In the acute and developmental comparative cholinesterase studies, an overall study LOAEL (lowest observed adverse effect level) of 0.5 mg/kg bw was established for adults, PND11 (postnatal day) and PND21 pups, as well as in pregnant animals and their fetuses based on inhibition of brain cholinesterase activity. Since a NOAEL was not established for these studies, a benchmark dose analysis was conducted in an attempt to further refine the effect level.

Due to poor fit, the benchmark dose approach was not considered appropriate in this case and the LOAEL was used for risk assessment purposes. Based on the LOAELs and the difference in the degree of cholinesterase inhibition, it was concluded that there was a low level of concern for sensitivity in the younger population.

Results of the toxicology studies conducted on laboratory animals with acephate, along with the toxicology endpoints for use in the human health risk assessment, are summarized in Tables 1 and 2 of Appendix IV.

### 3.1.1 *Pest Control Products Act* Hazard Characterization – Acephate

For assessing risks from potential residues in food or from products used in or around homes or schools, the *Pest Control Products Act* requires the application of an additional 10-fold factor to threshold effects to take into account completeness of the data with respect to the exposure of, and toxicity to, infants and children, and potential prenatal and postnatal toxicity. A different factor may be determined to be appropriate on the basis of reliable scientific data.

With respect to the completeness of the toxicity database as it pertains to the exposure of and toxicity to infants and children, extensive data were available for acephate. The database contains the full complement of required studies including developmental toxicity studies in mice, rats and rabbits and a three generation reproductive toxicity study in rats. A set of comparative cholinesterase toxicity studies and a developmental neurotoxicity study in rats were also available for acephate.

With respect to potential prenatal and postnatal toxicity, decreased pup survival (considered a serious endpoint) was observed in the 3-generation reproductive toxicity study in rats. However, concern for this endpoint was tempered by the presence of maternal toxicity (effects on body weight) at the same dose level. In a developmental toxicity study in mice, there was an increased incidence of external (polydactyly) and skeletal abnormalities (shortening of long bones, incomplete ossification of phalanges and absent phalanges) in the presence of maternal toxicity. In the rat and rabbit developmental toxicity studies, no evidence of teratogenicity or sensitivity of the young was noted.

In the recently reviewed comparative cholinesterase studies conducted with rats, effect levels were established based on the inhibition of brain cholinesterase activity. Overall, the studies revealed no sensitivity of the young. The rat developmental neurotoxicity study revealed a potential effect on memory of exposed male pups but only at a dosage level that resulted in significant inhibition of brain cholinesterase activity. Therefore, the database for acephate is considered complete for determining toxicity to the young. Since there is low concern for sensitivity of the young and adequate margins exist for serious endpoints noted in the database, the *Pest Control Products Act* factor was reduced to 1-fold.

### 3.1.2 Toxicology Summary – Methamidophos

A detailed review of the toxicological database for methamidophos, the primary metabolite of acephate, was conducted. Many details can be found in REV2007-11. Since that time, the toxicological database for methamidophos has been further updated with new studies and the endpoints for risk assessment have been revised. A summary of these endpoints can be found in Appendix IV, Table 3.

## 3.2 Occupational and Non-Occupational Risk Assessment

Occupational and nonoccupational risk is estimated by comparing potential exposures with the most relevant endpoint from toxicology studies to calculate a margin of exposure (MOE). This is compared to a target MOE incorporating uncertainty factors protective of the most sensitive population subgroup. If the calculated MOE is less than the target MOE, it does not necessarily mean that exposure will result in adverse effects, but mitigation measures to reduce risk would be required.

In the environment, acephate metabolizes or breaks down to methamidophos, which produces the same toxic effect as acephate (cholinesterase inhibition). Therefore, when there is potential exposure to both acephate and methamidophos from acephate use, the combined risk was considered using the aggregate risk index (ARI). The ARI is a method of measuring combined risk when exposure occurs via multiple routes or pathways and different toxicological points of departure and uncertainty factors are defined. ARIs greater than or equal to one do not require mitigation. The ARI is an extension of the MOE concept. As with the MOE, risk increases as the ARI decreases.

For example, an ARI for dermal exposure from both acephate and methamidophos would be calculated using the following equation:

$$\text{ARI}_{\text{dermal}} = \frac{1}{\dfrac{\text{ACP target MOE}_{\text{dermal}}}{\text{ACP MOE}_{\text{dermal}}} + \dfrac{\text{MOM target MOE}_{\text{dermal}}}{\text{MOM MOE}_{\text{dermal}}}}$$

### 3.2.1 Toxicology Endpoint Selection for Occupational and Non-Occupational Risk Assessment

#### 3.2.1.1 Short-, Intermediate- and Long-term Dermal Risk Assessment - Acephate

For short-, intermediate- and long-term dermal risk assessment, two 3-week dermal toxicity studies in the rat were selected. A NOAEL of 50 mg/kg bw/day from one of the 3-week dermal toxicity studies was selected based on depressed brain cholinesterase (BChE) activity observed at the next highest dose of 60 mg/kg bw/day in the other 3-week dermal toxicity study. These studies were selected as the route of exposure was considered appropriate and the endpoint affected (depressed cholinesterase) was consistent with the remainder of the database. As the available toxicology database suggests that increased duration of exposure (subchronic to chronic) would not significantly increase the toxicity of acephate, these studies can be used for all durations of exposure. The low concern for sensitivity of the young alleviated any uncertainty related to the fact that these dermal toxicity studies were conducted in adults. The target Margin of Exposure (MOE) was 100, accounting for standard uncertainty factors of 10-fold for interspecies extrapolation and 10-fold for intraspecies variability. For the residential risk assessment, the *Pest Control Products Act* factor was reduced to 1-fold.

#### 3.2.1.2 Short-, Intermediate- and Long-term Inhalation Risk Assessment - Acephate

For short-, intermediate- and long-term inhalation risk assessment, the NOAEL of 0.001 mg/L from a 28-day inhalation toxicity study in rats was selected (equal to 0.26 mg/kg bw/day; mg/L × 100% absorption × conversion factor of 43.47 L/hr/kg for Sprague-Dawley rats × daily exposure of 6 hrs × default activity factor of 1). This NOAEL is based on the cholinesterase inhibition (BChE and EChE) observed at the next higher dose level (0.003 mg/L). This study was selected as the route of exposure was considered appropriate and the endpoint affected (depressed cholinesterase) was consistent with the remainder of the database. As the available toxicology database suggests that increased duration of exposure (subchronic to chronic) would not significantly increase the toxicity of acephate, this study can be used for all durations of exposure. For occupational exposures, a target MOE of 100 was selected, which includes uncertainty factors of 10-fold for interspecies extrapolation and 10-fold for intraspecies variability. For residential exposures, a target MOE of 100 was selected, which includes a 10-fold uncertainty factor for interspecies extrapolation, 10-fold uncertainty factor for intraspecies variability and a *Pest Control Products Act* factor of 1-fold, as discussed in the *Pest Control Products Act* Hazard Characterization section. These values were considered to be protective of all worker populations including women who may be pregnant or nursing.

#### 3.2.1.3 Aggregate Short-term Risk Assessment -Acephate

Aggregate exposure to acephate has been considered to address the co-occurrence of exposure from residential use (dermal) and from the diet (food, drinking water) that could occur on a short-term basis (for example, from 1-day to less than 1-month duration). As inhibition of brain cholinesterase was a common toxic effect among all routes of exposure and increased duration of exposure would not have significant impact on the toxicity of acephate, the most relevant studies were short-term route-specific studies (13-week oral, 3-week dermal and 4-week inhalation studies as identified in Table 2 of Appendix IV), with brain cholinesterase inhibition as the endpoint of concern. Target MOEs were consistent with those outlined above for the route-specific assessments, which are considered to be protective of all populations.

#### 3.2.1.4 Short-, Intermediate- and Long-term Dermal Risk Assessment – Methamidophos

See Appendix IV Table 3.

#### 3.2.1.5 Aggregate Short-term Risk Assessment – Methamidophos

See Appendix IV Table 3.

#### 3.2.1.6 Combined Acephate and Methamidophos Dermal and Inhalation Risk Assessment

Given that methamidophos is a major transformation product of acephate, the co-occurrence of acephate and methamidophos exposure needs to be considered (combined assessment). Both of these organophosphates share a common mechanism of toxicity, namely cholinesterase inhibition. Accordingly, endpoints based on brain cholinesterase inhibition were considered relevant for the combined assessment.

For the occupational and residential risk assessment, when there was potential co-occurrence of exposure to both acephate and methamidophos, an Aggregate Risk Index was calculated as described in Section 3.2 using the toxicology endpoints described in Section 3.2.1.3.

#### 3.2.1.7 Cancer Assessment –Acephate and Methamidophos

Since there was no evidence of oncogenicity at doses below the maximum tolerated dose, a cancer risk assessment was not conducted.

#### 3.2.1.8 Dermal Absorption – Acephate and Methamidophos

Since a dermal toxicity study was chosen for all the dermal endpoints for acephate, a dermal absorption factor was not required. For methamidophos, oral toxicology studies were used for the dermal risk assessment. Therefore, a chemical-specific dermal absorption of 10% was used based on a weight of evidence approach that considered numerous studies including human, monkey and rat *in vivo* dermal absorption studies.

### 3.2.2 Occupational Exposure and Risk Assessment

Workers can be exposed to acephate through mixing/loading or applying the pesticide, and when entering a treated site to conduct activities such as scouting and/or handling treated crops.

As methamidophos is formed once acephate is in the environment, exposure to methamidophos from acephate during mixing/loading and application is considered to be negligible.

#### 3.2.2.1 Mixer, Loader and Applicator Exposure and Risk Assessment

The following exposure scenarios were examined:

- Open mixing/loading of wettable (soluble) powder
- Open mixing/loading of pelletized formulation
- Airblast application to cranberries, outdoor ornamentals (trees, shrubs, flowers) and other trees
- Groundboom application to Brussels sprouts, cabbage, cauliflower, head lettuce, celery, sweet pepper, corn, cranberries, potatoes, tobacco, tomatoes and outdoor ornamentals (trees, shrubs, flowers)
- Soil injection application to Saskatoon berries

- Chemigation application to cranberries
- Manually pressurized handwand applications to outdoor and indoor ornamentals (trees, shrubs, flowers), and other trees
- Mechanically pressurized handgun applications to outdoor and indoor ornamentals (trees, shrubs, flowers), and other trees
- Backpack application to outdoor and indoor ornamentals (trees, shrubs, flowers), and other trees
- Tree trunk injection using pipette and /or syringe
- Tree trunk injection using capsules
- Handheld and stationary mist blower application in greenhouses
- Handheld and stationary fogger application in greenhouses

With the exception of roses, ornamentals grown in greenhouses are not specifically listed on the label and were not fully addressed in 2004 (PACR2004-40) or 2007 (REV2007-02). Since then, directions for this use on the current label have been reconsidered, and can be interpreted to include all ornamentals. As a result, this assessment includes manually and mechanically pressurized hand-wand/gun, backpack, mist blower and fogger use in greenhouses for ornamentals.

Based on the number of applications and timing of application, workers applying acephate would generally have a short-term (<30 days) duration of exposure. Custom applicators may also have intermediate-term (for example, up to several months) exposure for those crops with multiple applications. An exception would be for greenhouse crops, which are considered to have intermediate- to long-term (for example, greater than several months) duration of exposure.

The PMRA estimated handler exposure based on different levels of personal protection equipment (PPE):

- Baseline PPE: Long pants, long-sleeved shirt and chemical-resistant gloves (unless specified otherwise). For groundboom application, this scenario does not include gloves, as the data quality was better for non-gloved scenarios than gloved scenarios.

- Mid-Level PPE: Cotton coveralls over long pants, long-sleeved shirt and chemical-resistant gloves.

- Maximum PPE: Chemical-resistant coveralls over long-sleeved shirt, long pants and chemical-resistant gloves

- Engineering Controls: Represents the use of appropriate engineering controls, such as closed cab tractor or closed loading systems. For groundboom and airblast applicators, the engineering controls comprised closed cab and baseline PPE. Engineering controls are limited for handheld application methods.

- Headgear [airblast application only]: Open cab, chemical-resistant coveralls over long sleeved shirt, long pants, chemical-resistant headgear and chemical-resistant gloves.

- Respirator: a NIOSH approved respirator with a canister approved for pesticides.

A chemical-specific exposure study was submitted to the Agency for the pellet formulation. It measured the dermal and inhalation exposure to workers who mixed and loaded a pelletized formulation of acephate. This study was considered in the risk assessment for mixing and loading the pellet formulation for most uses.

No chemical-specific handler exposure data was submitted for the soluble powder formulation of acephate; therefore, dermal and inhalation exposures were estimated using data from the Pesticide Handlers Exposure Database (PHED), Version 1.1. The PHED is a compilation of generic mixer/loader/applicator passive dosimetry data with associated software which facilitates the generation of scenario-specific exposure estimates based on formulation type, application equipment, mix/load systems and level of personal protective equipment (PPE). In most cases, PHED did not contain appropriate data sets to estimate exposure to workers wearing coveralls, chemical-resistant coveralls or a respirator. This was estimated by incorporating a 75% clothing protection factor for coveralls, a 90% clothing protection factor for chemical-resistant coveralls, and a 90% protection factor for a respirator into the unit exposure data. Similarly, a 90% protection factor was applied to head and neck dermal unit exposure values for chemical-resistant head gear. Chemical resistant head gear includes so'westers, or large brimmed, water-proof hats, and hoods with sufficient neck protection.

Inhalation exposures were based on light inhalation rates (17 LPM) except for backpack applicator scenarios which were based on moderate inhalation rates (27 LPM).

Adequate data were not available to assess exposure when injecting into tree trunks using a pipette and/or syringe. To assess this scenario, mix/load PHED data for soluble powder was used for the soluble powder formulation and the mix/load unit exposure values from the pellet study were used assuming a possible new pellet formulation. Using such data for this scenario is highly uncertain and PMRA has low confidence in the assessment.

Data were not available to assess worker exposure from handheld mist blowers and foggers in greenhouses. Exposure is expected to be significant, especially due to potential inhalation of mist and/or fog.

Mixer/loader/applicator exposure estimates are based on the best available data at this time. The generation of exposure data representative of modern application equipment and engineering controls may potentially refine the risk assessment. Biological monitoring data could also further refine the assessment.

Occupational risk estimates associated with mixing/loading/and applying acephate are summarized in Tables 1 and 2 of Appendix V. For some crops, due to dietary risk concerns, mitigation, including decreased application rates, is being proposed. Handler exposure of the proposed reduced rates has also been presented in the tables. MOEs have been combined for dermal and inhalation exposure since the toxicological endpoint of concern (brain cholinesterase inhibition) and the target MOE (100) are the same for both routes of exposure.

For the soluble powder formulation, most calculated MOEs based on the current label PPE and application rates are below the target MOE, and are of concern. With the use of PPE, some uses have calculated MOEs that are above the target, and are, therefore, acceptable, provided the mitigation is implemented.

The following uses with the soluble powder formulation have calculated MOEs below the target MOE of 100 and are of concern, even with consideration of maximum feasible personal protective equipment and/or engineering controls:

- sweet and seed corn (all equipment)
- potatoes (all equipment)
- Saskatoon berries (all equipment)
- tomatoes (all equipment)
- cranberries (chemigation)
- outdoor ornamentals (groundboom and mechanically pressurized handguns)
- greenhouse (mechanically pressurized hand guns)
- trees (mechanically pressurized hand guns)
- tobacco (except at a rate of 563 g a.i./ha)

Calculated MOEs for dermal and inhalation exposure combined also marginally failed to meet the target MOE of 100 for ground boom application to Brussels sprouts, cabbage, cauliflower, lettuce, celery, sweet pepper and tobacco, even when including maximum PPE and a respirator. However, for these crops, with the exception of tobacco, mitigation is required for the dietary assessment, including reducing the application rate to 0.56 kg a.i./ha. At the proposed mitigated application rate, the combined MOE reaches the target MOE for these crops.

Exposure calculations based on use of the soluble powder to mix and inject into tree trunks via pipettes and/or syringes resulted in MOEs slightly below the target of 100. However, PMRA has low confidence in this assessment, as the data used to estimate exposure for this scenario is not necessarily representative of this use, could underestimate exposure, and is highly uncertain. Thus, the calculated MOEs are of concern.

Due to the risk concerns identified and the extensive mitigation required for the soluble powder formulation, exposure to mixer/loaders and applicators was also calculated assuming that a currently registered pellet formulation could replace the soluble powder formulation for all foliar, soil injection and some tree injection application scenarios.

For the pellet formulation the calculated MOEs exceed the target MOEs and are not of concern when baseline PPE is worn, with the following exceptions:

- For mixing/loading and applying to potatoes, a respirator would be required. However, this use is proposed for phase-out due to dietary risk concerns.
- For mixing/loading and applying using mechanically pressurized handguns on ornamentals (indoors and outdoors), cut flowers (indoors and outdoors) and trees, a respirator would be required.

There is no data available to assess exposure during handheld mist blower or handheld fogger application when using either the soluble powder formulation or the pellet formulation. In the absence of data to estimate exposure, a label statement will be required prohibiting application with handheld mist blowers and handheld foggers. This label direction can be removed if data are submitted to estimate exposure and demonstrate no risks of concern.

In conclusion, for occupational handler exposure, extensive mitigation is required for most uses when using the soluble powder formulation. To keep mitigation measures feasible for most uses, the PMRA is proposing that the soluble powder formulation be cancelled and that the registrant apply for the registration of additional uses to the currently registered pellet formulation.

There are no concerns with implant cartridges.

#### 3.2.2.2 Postapplication Worker Exposure and Risk Assessment

The postapplication occupational risk assessment considers exposures to workers who enter treated sites to conduct agronomic activities involving foliar contact (for example, pruning, thinning, harvesting or scouting). Based on the acephate use pattern, there is potential for short-to-intermediate term (>1 day to several weeks) postapplication exposure for most scenarios. For greenhouse uses, there is potential for intermediate- to long-term (from several weeks to several months) postapplication exposure.

For workers entering agricultural crops which have been treated with acephate, there is potential for postapplication dermal exposure to both residues of acephate and residues of the more toxic metabolite, methamidophos, which forms during environmental degradation.

Potential exposure of postapplication workers was estimated using updated activity-specific transfer coefficients (TCs) (ARTF 2008) and dislodgeable foliar residue (DFR) values. The DFR refers to the amount of residue that can be dislodged or transferred from a surface, such as leaves of a plant. The TC is a measure of the relationship between exposure and DFRs for individuals engaged in a specific activity, and is calculated from data generated in field exposure studies. The TCs are specific to a given crop and activity combination (for example, hand harvesting apples, scouting late season corn) and reflect standard agricultural work clothing worn by adult workers. Postapplication exposure activities for agricultural crops include (but are not limited to): harvesting, pruning, scouting and thinning.

Chemical-specific DFR studies available in the literature and submitted to the PMRA were considered in the postapplication risk assessment. Of these, 4 studies were considered acceptable for risk assessment purposes. These studies included measurement of methamidophos. The amount of dislodgeable residues is expected to be the same for the wettable powder formulation and the pellet formulation. Both formulations are designed to dissolve in the water before application.

Due to the limited number of acceptable DFR studies available to the PMRA for the postapplication risk assessment, the extrapolation of study DFR data to a wide variety of crops was required. Extrapolation was based on a comparison of general crop morphology, application equipment, application regime, foliage types, application rates, study conditions and climatic zones. See Table 3.2.2.2 for a list of the studies that were used to estimate residues for Canadian agricultural crops on the acephate labels. Since the studies available are not necessarily representative of some Canadian crops, this extrapolation represents an uncertainty in the postapplication assessment.

**Table 3.2.2.2 Available DFR Studies and their Application to Canadian Crops**

| Study | Residue | Study Data | | | Canadian Crops |
|---|---|---|---|---|---|
| | | Equation | Peak DFR [a] | Daily Dissipation [b] | |
| Greenhouse Rose Study | ACP | Y=-0.2257x + 0.1751 | 13% | 20% | Greenhouse crops (cut flowers, roses, ornamentals) |
| | MOM | N/A[c] | 0.47% | 14% | |
| Tobacco Study | ACP | Y=-0.1315x -1.1804 | 16% | 12% | Tobacco |
| | MOM | Y=-0.0871x -3.446 | 0.35% | 8% | |
| Cauliflower Study | ACP | Y=-0.1349x -0.7081 | 3.7% | 13% | Brussels sprouts, cabbage, cauliflower |
| | MOM | Y=-0.0615x -4.714 | 0.06% | 6% | |
| Succulent Bean Study | ACP | Y=-0.1958x -0.3247 | 29% | 18% | Lettuce, celery, corn, potato, sweet pepper, tomato, cut flowers & roses (outdoors) |
| | MOM | Y=-0.1088x -3.490 | 0.60% | 10% | |
| Modified Default DFR | ACP | N/A | 25%[d] | 10%[d] | Cranberries, ornamentals (trees, shrubs, flowers), deciduous trees (farm woodlots, shelterbelts, rights-of-way, parks), Coniferous trees (Christmas trees, farm woodlots, shelterbelts, rights-of-way, parks) |
| | MOM | | 0.60%[e] | 10%[d] | |

DFR= dislodgeable foliar residue, ACP = acephate; MOM= methamidophos; N/A= not applicable

[a] Peak DFR is considered to be the percentage of the application rate (kilograms per hectare) that is dislodgeable from the foliage (micrograms per square centimetre) on the day of the highest residue following the last application.

[b] Daily dissipation is the rate at which the dislodgeable foliar residue degrades per day; derived from the slope of the DFR curve (the natural log of transferable residue vs. time).

[c] The coefficient of determination ($r^2$) value was below 0.85, so the ln linear equation could not be used to predict methamidophos residues. Actual study data was used instead.

[d] The available DFR data could not be extrapolated to some Canadian crops. Instead, default PMRA values were applied.

[e] Estimate of methamidophos peak DFR residue based on approximate highest peak DFR observed in the available studies.

For workers entering a treated site, restricted-entry intervals (REIs) are calculated to determine the minimum length of time required before workers can enter after application to perform tasks involving hand labour. An REI is the duration of time that must elapse in order to allow residues to decline to a level where there are no risks of concern for postapplication worker activities (for example, performance of a specific activity results in exposures above the target MOE of >100 for short- to long-term dermal exposure, or above the target ARI (>1).

Based on current label rates, in order to achieve the target MOEs/ARIs for postapplication workers in agricultural scenarios, some current REIs would need to be increased or decreased in duration. Calculated REIs ranged from 12 hours to 27 days for outdoor uses. For greenhouse uses, calculated REIs ranged from 12 hours to 2 days. Table 3 in Appendix V summarizes the postapplication exposure and risk assessment.

Most proposed REIs may be considered agronomically feasible for crops; however some may not be feasible, especially those for outdoor cut flowers including cut roses (11-day REI for some tasks), and greenhouse cut flowers including cut roses (2-day REI for some tasks). For the dietary risk assessment, mitigation for some crops is proposed, including reduced application rates and number of applications. Table 4 in Appendix V summarizes the postapplication exposure and risk assessment assuming that rates are lowered and the number of applications is reduced for some crops as specified in the dietary risk assessment.

The assessments could be refined and uncertainties reduced with the following data:

- enhanced information on the acephate use pattern, including typical rates and number of applications per season
- survey information on critical worker activities that typically take place for each crop during the use season, and the timing of these activities with respect to crop growth and applications of acephate
- DFR data for key Canadian crops conducted under typical Canadian use conditions;
- passive dosimetry or biological monitoring data

The PMRA encourages stakeholders to provide use information as described above and comment on the feasibility of the proposed REIs. Crops with REIs that are not agronomically feasible and for which further mitigation (for example, reduced rates, number of applications) is not possible and/or for which data for refinement purposes has not been submitted, may require removal from the acephate label. In particular, this may include the following crops: outdoor cut flowers (including cut roses), and greenhouse cut flowers (including cut roses).

The following data may help to refine the risk assessment:

- Data to estimate exposure to postapplication workers conducting tasks with indoor and outdoor cut flowers. These data may refine the risk assessment for REIs that may not be agronomically feasible. Such data include but are not limited to, dislodgeable foliar residue studies, passive dosimetry studies, or biological monitoring studies for this specific worker population.

Although not on the label, foggers may be used in greenhouses. Due to the pesticide residues remaining in the air, inhalation exposure may occur to postapplication workers. Data were not available to assess inhalation exposure. In the absence of data, a label statement will be required prohibiting the use of all foggers for acephate products. This label direction can be removed if data are submitted to estimate exposure and demonstrate no risks of concern.

Postapplication exposure from tree injection and implant capsules is not of concern.

### 3.2.3 Non-Occupational and Residential Exposure and Risk Assessment

Nonoccupational or residential risk assessment estimates risks to the general population, including children/youths, during or after pesticide application. There are no registered domestic class products for acephate. However, there is potential for exposure to adults, youth and children through contact with transferable residues following commercial application of acephate on residential ornamentals (trees, shrubs and flowers).

#### Non-Occupational Mixer, Loader and Applicator Exposure and Risk Assessment

As there are no domestic class products registered for acephate, a mixer/loader/applicator assessment was not required.

#### Non-Occupational Postapplication Exposure and Risk Assessment

There is potential for exposure to adults, youth and children through contact with transferable residues following commercial application of acephate on residential ornamentals (trees, shrubs and flowers). Two application methods are specified on acephate labels: tree injection and foliar spray.

Treatment to trees and ornamentals using implant cartridges, and various methods of tree trunk injection that result in no contact with the foliage, are expected to result in minimum exposure to residential populations such as children and gardeners. Therefore, risks of concern were not identified.

The foliar spray method of application is expected to result in transferable residues on residential ornamentals (trees, shrubs and flowers). Short- to intermediate- term exposure is expected for residential gardening.

Postapplication exposure estimates were generated based on the Revised EPA 2012 Standard Operating Procedures (SOPs) for Residential Exposure Assessments and chemical-specific DFR data. The DFR data has been described previously in Section 3.2.2.2. For the purposes of residential gardening, the DFR study that was selected for outdoor cut flowers was used.

The transfer coefficient (TC) used in the assessment is based on a composite group of ARTF data for residential gardening. Four studies are included (weeding, tying, harvesting, pinching) in the residential gardening TC. The composite TC was scaled for body surface area and adjusted for gardeners that were assumed to wear short-sleeve shirts and short pants.

Exposure estimates for adults, youth and children are presented in Table 1 of Appendix VI. For foliar applications to trees and ornamentals, quantitative estimates of exposure and risk were determined for both acephate and methimidophos, based on the available data or using standard defaults in the absence of data. Estimates of exposure did not reach the target MOE or ARI for adults and children for all postapplication scenarios, and are, therefore, of concern. To mitigate risk, the PMRA proposes that commercial foliar application of acephate products in residential areas not be permitted.

### 3.3 Dietary Risk Assessment

In a dietary exposure assessment, the PMRA determines how much pesticide residues, including residues in milk and meat, may be ingested with the daily diet. Exposure to acephate and methamidophos from potentially treated imported food commodities is also included in the assessment. These dietary assessments are age specific and incorporate the different eating habits of the population at various stages of life. For example, the assessments take into account differences in children's eating patterns, such as food preferences and the greater consumption of food relative to their body weight when compared to adults. Dietary risk is then determined by comparing the exposure to the toxicity reference dose. High toxicity may not indicate high risk if the exposure is low. Similarly, there may be risk from a pesticide with low toxicity if the exposure is high.

Methamidophos is a major metabolite of acephate and may be formed in food and drinking water as a result of acephate use; thus dietary exposure and risk assessments were conducted for both acephate and methamidophos.

The PMRA considers limiting use of a pesticide when risk exceeds 100% of the reference dose. PMRA's Science Policy Note SPN2003-03, *Assessing Exposure from Pesticides, A User's Guide*, presents detailed acute and chronic risk assessments procedures.

In situations where the need to mitigate dietary exposure has been identified, the following options are considered. Dietary exposure from Canadian agricultural uses can be mitigated through changes in the use pattern. Revisions of the use pattern may include such actions as reducing the application rate or the number of seasonal applications, establishing longer preharvest intervals (PHIs), and/or removing uses from the label. In order to quantify the impact of such measures, new residue chemistry studies which reflect the revised use pattern may be required. These data would also be required in order to amend maximum residue limits (MRLs) to the appropriate level. Imported commodities which have been treated also contribute to the dietary exposure and are routinely considered in the risk assessment. The mitigation of dietary exposure that may arise from treated imports is generally achieved through the amendment or establishment of MRLs.

Residue estimates used in the dietary exposure assessment may be conservatively based on the maximum residue limits (MRL) or the field trial data representing the residues that may remain on food after treatment at the maximum label rate. Monitoring data representative of the national food supply may also be used to derive a more accurate estimate of residues that may remain on food when it is purchased. These include the Canadian Food Inspection Agency's National Chemical Residue Monitoring Program and the United States Department of Agriculture Pesticide Data Program (PDP). For acephate and methamidophos, the majority of residue estimates were based on monitoring data. When monitoring data were not available, the residue estimate was based on field trial data. Percent crop treated information, food supply data, and chemical specific processing factors were also included in the assessment where available. Overall, a highly refined dietary exposure and risk assessment was conducted for acephate and methamidophos.

Acute and chronic dietary risk assessments were conducted using the Dietary Exposure Evaluation Model (DEEM–FCID™, Version 2.14), which uses food consumption data from the United States Department of Agriculture's Continuing Surveys of Food Intakes by Individuals, 1994–1996 and 1998.

Acephate and methamidophos have been subject to post market assessments in both the United States and in Canada. Recent voluntary and regulatory measures for these pesticides have been incorporated into this current acephate reevaluation. All previous uses of methamidophos have been excluded in the assessment, as these uses are being phased out in Canada and the United States. In addition, all forms of green beans or succulent beans were excluded from the assessment.

Acephate is not registered for use on green beans in Canada, but was registered in the United States. The monitoring data available indicate relatively high residue levels of acephate (up to 3 ppm) and methamidophos (up to 1 ppm) in American green beans. The American green beans can potentially be imported to Canada and is of risk concern when considered in the dietary assessment. In December 2011, the USEPA announced that acephate use on green beans was being phased out. As such, the exposure from green beans is expected to reduce to negligible levels when the phase-out is complete and the commodity was, therefore, removed from the dietary assessment. To ensure that residue levels of acephate and methamidophos in green beans do not pose risk concerns in the future, the MRL for green beans for acephate (currently 1 ppm) and methamidophos (currently 0.3 ppm) are proposed for revocation. Acephate and methamidophos MRLs on dry beans will not be revoked, as there were no dietary risk concerns for dry beans.

For more information on dietary risk estimates, see Appendix VII.

### 3.3.1 Determination of Acute Reference Dose

**Acephate: General Population (including pregnant women, infants and children)**

To estimate acute dietary risk (1-day), the acute comparative cholinesterase assay in rats was selected for risk assessment. A LOAEL of 0.5 mg/kg bw was established based on depressed brain cholinesterase (BChE) activity in male and female adults, male postnatal day 11 pups and female postnatal day 21 pups at this dosage level. This value was selected since it was based on the most sensitive endpoint available in the database, occurred following a single exposure and is protective of other neurological and systemic effects. Standard uncertainty factors of 10-fold for interspecies extrapolation and 10-fold for intraspecies variability have been applied. An additional uncertainty factor of threefold was applied for the lack of a NOAEL. As discussed in the *Pest Control Products Act* Hazard Characterization section, the *Pest Control Products Act* factor has been reduced to onefold. The composite assessment factor (CAF) is 300.

The ARfD is calculated according to the following formula:

$$\text{ARfD} = \frac{\text{LOAEL}}{\text{CAF}} = \frac{0.5\ \text{mg/kg bw}}{300} = 0.0017\ \text{mg/kg bw of acephate}$$

The ARfD is considered protective of all populations including infants and children.

**Methamidophos: General Population (including pregnant women, infants and children)**

See Appendix VII, Table 3.

**Combined Acephate and Methamidophos: General Population (including women, infants and children)**

A quantitative acute combined risk assessment to address dietary exposure was not conducted for acephate and methamidophos. For acephate, an acute comparative cholinesterase study was available while a similar study was not conducted with methamidophos; no NOAEL could be established in the acephate study and the data provided a poor fit for benchmark dosing. Acute neurotoxicity studies were available for both compounds but no NOAEL was established in the acephate study. Due to the lack of NOAELs, the inability to benchmark dose and variable data, the ability to conduct a quantitative combined risk assessment for an acute scenario was constrained.

### 3.3.2 Acute Dietary Exposure and Risk Assessment

Acute dietary risk is calculated by considering the highest ingestion of acephate and methamidophos that would be likely on any one day, and using food consumption and food residue values. A statistical analysis allows all possible combinations of consumption and residue levels to be combined to estimate a distribution of the amount of acephate and methamidophos residues that might be consumed individually in a day. A value representing the high end (99.9th percentile) of this distribution is compared to the ARfD, which is the dose at which an individual could be exposed on any given day and expect no adverse health effects. When the expected intake of residues is less than the ARfD, then acute dietary exposure is considered to be acceptable.

The acute exposure estimate from food alone accounted for $< 36\%$ of the ARfD for acephate and $< 57\%$ of the ARfD for methamidophos for all population subgroups and is not of concern.

As noted in Section 3.3.1, a combined acute risk assessment could not be conducted for acephate and methamidophos. Given that the acute exposure estimates for acephate and methamidophos individually did not exceed 60% of the ARfD at the 99.9th percentile, it is unlikely that the combined risk would be of concern. The PMRA will quantitatively assess the cumulative risks of organophosphate pesticides once all individual organophosphates have been reevaluated._This cumulative assessment will consider potential exposure to all organophosphate pesticides causing toxicity in the same manner.

### 3.3.3 Determination of Acceptable Daily Intake

#### Acceptable Daily Intake (ADI)

#### Acephate: General Population (including pregnant women, infants and children)

To estimate dietary risk from repeat or chronic exposure, the LOAEL of 0.12 mg/kg bw/day from the 13-week dietary toxicity study in rats was selected. The effect observed at this dose level was a slight depression of brain cholinesterase, which was believed to be close to the threshold of a NOAEL. The available toxicology database suggests that increased duration of oral exposure (subchronic to chronic) would not significantly increase the toxicity of acephate. Uncertainty factors of 10-fold for interspecies extrapolation as well as 10-fold for intraspecies variability were used to derive the ADI. Due to the minimal effects observed at the LOAEL, the uncertainty for lack of a NOAEL was established at onefold. As discussed in the *Pest Control Products Act* Hazard Characterization section, the *Pest Control Products Act* factor has been reduced to onefold. The composite assessment factor (CAF) is 100.

The ADI is calculated according to the following formula:

$$\text{ADI} = \frac{\text{LOAEL}}{\text{CAF}} = \frac{0.12 \text{ mg/kg bw/day}}{100} = 0.0012 \text{ mg/kg bw/day of acephate}$$

The ADI provides a margin of >2,000 to the NOAEL for offspring viability in the rat reproduction study and is thus considered to be protective of all populations including infants and children.

#### Methamidphos: General Population (including pregnant women, infants and children)

See Appendix VII, Table 3.

#### Combined Acephate and Methamidophos: General Population (including pregnant women, infants and children)

A long-term combined risk assessment for acephate and methamidophos to address dietary exposure was performed. As inhibition of brain cholinesterase was a common toxic effect among all routes of exposure and increased duration of exposure did not have significant impact on the toxicity of acephate or methamidophos, the most relevant studies were those selected for the Acceptable Daily Intake (13-week oral study for acephate, reproduction study for methamidophos) which were based on brain cholinesterase inhibition. Target MOEs were consistent with those selected for the acephate and methamidophos-specific chronic dietary assessments and are considered to be protective of all populations.

**Cancer Assessment**

Since there was no evidence of oncogenicity for acephate and methamidophos at doses below the maximum tolerated dose, a cancer risk assessment was not conducted.

### 3.3.4 Chronic Dietary Exposure and Risk Assessment

The chronic dietary risk was calculated by using the average consumption of different foods and the average residue values on those foods. This expected intake of residues was then compared to the ADI. When the expected intake of residues is less than the ADI, then chronic dietary exposure is not of concern.

The estimated chronic exposure from food accounted for < 1% of the ADI for acephate and < 2% of the ADI for methamidophos for all population subgroups and is not of concern.

The combined chronic risk was calculated for acephate and methamidophos by using the aggregate risk index approach (ARI), which considers the additive risk. An ARI of greater than 1 indicates no risks of concern.

The ARI for acephate and methamidophos from exposure to food alone was > 32 for all population subgroups and is not of concern.

## 3.4 Exposure from Drinking Water

### 3.4.1 Concentrations in Drinking Water

Estimated environmental concentrations (EECs) of acephate and methamidophos in potential drinking water sources (groundwater and surface water) were determined using computer simulation models. An overview of how the EECs are estimated is provided in the PMRA's Science Policy Notice SPN2004-01, *Estimating the Water Component of a Dietary Exposure Assessment*. EECs in groundwater were calculated using the LEACHM model to simulate leaching through a layered soil profile over a 50-year period. The concentrations calculated using LEACHM are based on the flux, or movement, of pesticide into shallow groundwater with time. EECs in surface water were calculated using the PRZM/EXAMS models, which simulate pesticide runoff from a treated field into an adjacent water body and the fate of a pesticide within that water body. Pesticide concentrations in surface water were estimated in two types of vulnerable drinking water sources, a small reservoir and a prairie dugout.

The yearly application rate of acephate for uses on head lettuce, sweet and seed corn and potato was modeled at 3300 g a.i./ha (4 applications of 825 g a.i./ha). The application interval of seven days was assumed for potatoes and head lettuce, and five days for sweet corn. These were the use scenarios that generated the highest EECs. The environmental half-lives in soil and water were calculated individually for acephate and methamidophos for the separate modelling. Note that the modelling of methamidophos was conducted using the same scenarios and rate as used for acephate, but the rate was adjusted by the molecular ratio of 0.77 and the total conversion factor for acephate to methamidophos of 0.445, which, in turn, resulted in the yearly rate of 1132 g methamidophos/ha (4 applications of 283 g methamidophos/ha).

The highest EECs for acephate and methamidophos are presented in Table 3.4.1. Other use scenarios such as tobacco were also modelled but are not shown as they generated lower EECs. The model was run for 50 years in all scenarios. The EECs calculated for surface water reservoirs were used in the risk assessment, as modelling indicated much higher acephate and methamidophos EECs in the surface water as compared to groundwater.

**Table 3.4.1 Level 2 Estimated Environmental Concentrations of Acephate and Methamidophos in Potential Drinking Water Source**

| | **Groundwater EEC (µg a.i./L)** | | **Surface Water EEC (µg a.i./L)** | | | |
|---|---|---|---|---|---|---|
| | | | **Reservoir** | | **Dugout** | |
| | **Daily[1]** | **Yearly[2]** | **Daily[3]** | **Yearly[4]** | **Daily[3]** | **Yearly[4]** |
| Acephate[5] | 1.2 | 1.1 | 97 | 6.3 | 132 | 9.8 |
| Methamidophos[6] | 0.46 | 0.38 | 32 | 1.7 | 42 | 2.1 |

EEC = Estimated Environmental Concentration

[1] 90th percentile of daily average concentrations
[2] 90th percentile of yearly average concentrations
[3] 90th percentile of yearly peak concentrations
[4] 90th percentile of yearly average concentrations
[5] The highest modelled scenarios were based on sweet corn, head lettuce and potato use. For all 3 crops, 4 applications at 825 g acephate/ha (total of 3300 g acephate/ha) was used. An application interval of 7 days was used for potato and head lettuce and five days for sweet and seed corn.
[6] The highest modelled scenarios were based on sweet corn, head lettuce and potato use. For 3 crops, 4 applications at 283 g methamidophos/ha (total of 1132 g methamidophos/ha) was used. An application interval of 7days was used for potato and head lettuce and 5-days for sweet and seed corn.

### Refined Drinking Water Modelled Estimates

Based on the initial modelled drinking water EECs, acute exposure from food and drinking water exceeded the ARfD for both acephate and methamidophos for all population groups. As such, mitigation measures and refinements were examined in the drinking water modelling to reduce the EECs. Only the surface water scenarios were refined, as initial modelling indicated much higher acephate and methamidophos EECs in the surface water as compared to groundwater. The following considerations were made:

- Potato was removed from the use pattern and not considered in the modelling.

- For Brussels sprouts, cabbage, cauliflower, head lettuce, celery and sweet and seed corn, the lower application rate of 563 g a.i./ha with two applications and at 14-day application interval was used instead of 4 applications of 825 g a.i./ha with 5 to 7 day application intervals.

- For bell pepper, an application rate of 825 g a.i./ha with two applications and a 14-day application interval was used instead of four applications at 825 g a.i./ha with seven day application intervals.

- Tomato use was not considered in the modelling, since acephate is only applied to tomato crops during the transplant period.

- Methamidophos was modelled as an application to bare soil instead of foliar applications. This was considered reasonable, as methamidophos residues present in water are the result of the breakdown of acephate in either the soil or water.

- The conversion factor for the transformation of acephate to methamidophos was lowered from 0.445 to 0.251. The initial conversion factor was based on data from aerobic soil transformation studies and the assumption that all transformed acephate is converted to methamidophos at one time within a soil depth of 2 cm. This is considered conservative, as it does not account for methamidophos degradation and formation in other parts of the soil profile. Both acephate and methamidophos are highly mobile. For the refined conversion factor, the study data for methamidophos were used directly to calculate the value. This value is representative of the peak methamidophos concentration throughout the soil profile. The conversion factor is used to determine the application rate of methamidophos as a fraction of the amount of acephate applied to the crops.

- A percent crop area (PCA) of 15% was used to adjust the surface water EECs of acephate and methamidophos in the updated modelling instead of the previous assumption of 100%. This was based on Statistics Canada crop data collected through the Census of Agriculture. Using the 2006 data, the highest PCA of all crop uses for acephate, not including potatoes and tomatoes, was determined to be 13%. Given the uncertainties, such as the surrogate nature of the crop data, year to year cropping variation, and census privacy issues, a conservative value of 15% was chosen as a national maximum PCA. The 15% PCA adjustment factor was applied to all EECs produced through modelling using the following equation: Modelled EEC value × 0.15 = PCA adjusted EEC.

- Dugout modelling was not conducted because the crops that remain on the label are not important on the prairies and, therefore, there would be very limited impact on prairie dugouts.

Refined EECs were modelled using the same computer simulation models discussed previously. The model was run for 50-years for all scenarios. The highest EECs were based on bell pepper, sweet corn, and head lettuce and are reported in Table 3.4.2. As discussed earlier, only reservoir surface water EECs were modelled for the refined estimates. These estimates were used in the refined food and drinking water exposure and risk assessments. The yearly EEC was used for the chronic assessment. The entire 50-year distribution of the modelled EECs was incorporated into the probabilistic acute assessment as an additional refinement.

Before drinking water reaches the consumer, a certain amount of time will have elapsed during which time the pesticide contained in runoff water will have been exposed to the aquatic environment and aquatic degradation processes. This retention time prior to consumption reduces the concentration of the pesticides in the water and contributes to a reduction in EECs.

A retention time of two days, for example, would reduce concentrations of acephate and methamidophos by 15% based on the aerobic aquatic biotransformation half-lives of 8.8 days for acephate and eight days for methamidophos. As data are not readily available for appropriate lengths of retention times, this refinement was not included in the modelling.

**Table 3.4.2 Refined Level 2 Estimated Environmental Concentrations of Acephate and Methamidophos in Potential Drinking Water Source**

| | Groundwater EEC (µg a.i./L) | | Surface Water EEC (µg a.i./L) | | | |
|---|---|---|---|---|---|---|
| | | | Reservoir | | Dugout | |
| | Daily | Yearly | Daily[1] | Yearly[2] | Daily[1] | Yearly[2] |
| Acephate[3] | NM | NM | 6.9 | 0.46 | NM | NM |
| Methamidophos[4] | NM | NM | 0.82 | 0.046 | NM | NM |

EEC = Estimated Environmental Concentration, NM = Not Modelled

[1] 90th percentile of yearly peak concentrations

[2] 90th percentile of yearly average concentrations

[3] The highest modelled EECs were based on sweet and seed corn, head lettuce, and bell pepper use. For sweet corn and head lettuce, two applications at 563 g acephate/ha (total 1126 g acephate/ha) was used. For bell peppers, two applications at 825 g acephate/ha (total 1650 g acephate/ha) was used. For all three crops, an application interval of 14 days was used.

[4] The highest modelled EECs were based on sweet and seed corn, head lettuce, and bell pepper use. For sweet corn and head lettuce, two applications at 109 g methamidophos/ha (total 218 g methamidophos/ha) was used. For bell peppers, two applications at 159 g methamidophos/ha (total 318 g methamidophos/ha) was used. For all three crops, an application interval of 14 days was used.

### Monitoring Data

Limited drinking water monitoring data were available to the PMRA. The lack of details in the monitoring studies available to the PMRA did not allow for an estimation of residues of acephate and methamidophos in drinking water using the monitoring data.

In general, acephate and methamidophos were detected infrequently in monitored samples, which is consistent with the fact that they have relatively short half-lives in the environment. When detected, levels of both acephate and methamidophos were fairly close to the EECs predicted by the refined modelling. Only in isolated cases did concentrations detected in water exceed the drinking water EECs generated by the refined modelling. Detections above the refined modelling EEC (one sample for acephate and an unknown number of surface water samples (less than seven) for methamidophos) were from the later 1970s and 1980s, and were from sites in the United States where the environmental conditions and the intensity of use may not be reflective of current Canadian use conditions. Little additional information was available to put these detections in context.

### 3.4.2 Drinking Water Exposure and Risk Assessment

Based on initial modelled drinking water concentrations, the estimated acute exposure from food and drinking water ranged from 600-2900% of the ARfD for acephate and 1100-5400% of the ARfD for methamidophos for all population subgroups (see Table 2 in Appendix VII).

Due to the risk concerns identified, mitigation measures and additional refinements were considered in the drinking water modelling estimates. The mitigation measures considered include the phase-out of potato use, and the reduction of application rates, number of applications per season, and increasing application intervals for several crop uses. Details on the refinements are noted in Section 3.4.1. With the revised water modelled concentrations, the estimated acute exposure ranged from 23-49% of the ARfD for acephate and 33-56% of the ARfD for methamidophos for all population subgroups (Table 3 in Appendix VII). Therefore, exposure from acephate and methamidophos in food and drinking water are not of concern provided that the mitigation measures outlined in Section 3.4.1 are implemented.

The estimated chronic exposure for acephate and methamidophos in food and drinking water was not of concern. Based on initial modelled drinking water concentrations, the estimated acute exposure ranged from 8-36% of the ADI for acephate and 16-69% of the ADI for methamidophos for all population subgroups. With refined modelled drinking water concentrations, the estimated chronic exposure ranged from 1-3% of the ADI for acephate and 1-2% of the ADI for methamidophos for all population subgroups.

The combined chronic risk of acephate and methamidophos in food and drinking water was also calculated. The ARI based on initial water modelled concentrations was greater than two in all population subgroups except infants where the ARI was 0.9. With the refined modelled concentrations, the ARI was >20 for infants and all other population subgroups, and is not of concern.

As noted in Section 3.3.1, a combined acute risk assessment could not be conducted for acephate and methamidophos. The PMRA will assess the combined risks of organophosphate pesticides once all individual organophosphates have been re-evaluated. This cumulative risk assessment will consider potential exposure to all organophosphate pesticides causing toxicity in the same manner.

## 3.5 Aggregate Risk Assessment

Aggregate exposure is the total exposure to a single pesticide that may occur from food, drinking water, residential and other nonoccupational sources, as well as from all known or plausible exposure routes (oral, dermal, inhalation). Aggregate risk estimates are performed for those scenarios where the exposures met the target MOEs or ARI and were not of concern. The likelihood of co-occurrence is also considered prior to aggregation of these scenarios.

In the case of acephate, there is potential exposure from acephate foliar application to trees and ornamentals in residential areas, which could co-occur with dietary exposure from food and drinking water. However, as noted in Section 3.2.3, target MOEs or ARIs were not achieved for foliar applications to trees and ornamentals in residential areas and is of concern. To mitigate risk, PMRA proposes that commercial application of acephate products in residential areas not be permitted. Since foliar application to trees and ornamentals in residential areas is of concern, exposure from this use was not aggregated with exposure from food and drinking water.

Non-foliar treatments (for example, tree trunk injections or cartridges) result in no contact with the foliage and are expected to result in minimum exposure to residential populations. Exposure from this scenario would not significantly contribute to exposure from food and drinking water.

### 3.6 Incident Reports

As of June 23, 2015 there have been three incident reports (one human, two animal) submitted to the PMRA for products containing acephate, all of which occurred in the United States. The human incident was classified as moderate and involved an adult male who used a product containing acephate, resmethrin and triforine. The individual exposed to this product experienced ocular effects including blurred vision, burning and redness of the eyes and swelling of the fingers less than 30-minutes after exposure. One of the animal incidents involved the death of a three year old domestic short-haired cat that contacted an area treated with a product containing acephate, resmethrin and triforine and died shortly thereafter. The second incident involved the death of a dog after it had consumed ant bait that had been placed around a tree.

## 4.0 Impact on the Environment

### 4.1 Fate and Behaviour in the Environment

Available data indicate that acephate is nonpersistent in the environment. In aerobic soil the half-life was two days and in anaerobic soil it was less than seven days. In water, hydrolysis half-life was 60 days at pH 5-7; biotransformation was a more important route of transformation with the half-life of less than seven days. Acephate is stable to phototransformation in both water and soil.

Acephate is non-volatile from moist soil and water surface as indicated by Henry's law constantHenery's law constant law Constant ($4.9 \times 10^{-13}$ atm · $m^3$· $mole^{-1}$). The log $K_{OW} = -0.9$ indicates low potential for bioaccumulation. Although lab studies suggest that acephate would be very mobile in soil, ground water modelling indicates concentrations of acephate are expected to be very low (1.1 ug a.i./L, Appendix X), the calculated GUS value (0.39) suggests acephate is a nonleacher and field studies demonstrate no detection of acephate below 30 cm. The evidence suggests acephate is not expected to leach.

Acephate can enter the aquatic environment through spray drift and runoff from the treated field. Based on EECs from water modelling, acephate can impact the aquatic environment (Appendix X).

Methamidophos is a major transformation product of acephate, and it is nonpersistent in the environment (Appendix IX, Table 11).

### 4.2 Environmental Risk Characterization

The environmental risk assessment integrates the environmental exposure and ecotoxicology information to estimate the potential for adverse effects on nontarget species. This integration is achieved by comparing exposure concentrations with concentrations at which adverse effects occur. Estimated environmental exposure concentrations (EECs) are concentrations of pesticide in various environmental media, such as food, water, soil and air. The EECs are estimated using standard models which take into consideration the application rate(s), chemical properties and environmental fate properties, including the dissipation of the pesticide between applications. Ecotoxicology information includes acute and chronic toxicity data for various organisms or groups of organisms from both terrestrial and aquatic habitats including invertebrates, vertebrates, and plants. Toxicity endpoints used in risk assessments may be adjusted to account for potential differences in species sensitivity as well as varying protection goals (for example, protection at the community, population or individual level).

Initially, a screening level risk assessment is performed to identify pesticides and/or specific uses that do not pose a risk to nontarget organisms, and to identify those groups of organisms for which there may be a potential risk. The screening level risk assessment uses simple methods, conservative exposure scenarios (for example, direct application at a maximum cumulative application rate) and sensitive toxicity endpoints. A risk quotient (RQ) is calculated by dividing the exposure estimate by an appropriate toxicity value (RQ = exposure/toxicity), and the risk quotient is then compared to the level of concern (LOC). If the screening level risk quotient is below the level of concern, the risk is considered negligible and no further risk characterization is necessary. If the screening level risk quotient is equal to or greater than the level of concern, then a refined risk assessment is performed to further characterize the risk. A refined assessment takes into consideration more realistic exposure scenarios (such as drift to non-target habitats) and might consider different toxicity endpoints. Refinements may include further characterization of risk based on exposure modelling, monitoring data, results from field or mesocosm studies, and probabilistic risk assessment methods. Refinements to the risk assessment may continue until the risk is adequately characterized or no further refinements are possible.

### 4.2.1 Risks to Terrestrial Organisms

The risk assessment of acephate and its transformation product methamidophos to terrestrial organisms was based upon an evaluation of toxicity data for earthworm, bees, small mammals and birds (Table 2 and 3, Appendix IX). For the assessment of risk, toxicity endpoints chosen from the most sensitive species were used as surrogates for the wide range of species that can be potentially exposed following treatment with acephate.

Based on a tier one risk assessment (with laboratory data), acephate was shown to be toxic to bees when exposed to high enough concentrations, and therefore a potential risk to adult foraging bees from contact exposure. Foliage residue toxicity studies indicate that acephate/methamidophos exhibit toxic effects to honeybees and beneficial insects from 2 to 24 hours after application, indicating residual toxicity. Based on higher tier studies, there is also a potential for brood and adult toxicity from dietary exposure to residues in pollen and/or nectar brought back to the hive from application before bloom and during bloom. As such, mitigation is required on the label to reduce pollinator exposure (Table 4, Appendix IX).

Because exposure is dependent on the body weight of the organisms and the amount and type of food consumed, the risk assessment for birds and mammals (Tables 7 and 8, Appendix IX) considers a set of generic body weights (20, 100, 1000 g for birds and 15, 35, 1000 g for mammals) and food preferences (small insects for insectivores, fruits for frugivores, grain and seeds for granivores and leaves and leafy crop for herbivores.

Methamidophos, the major transformation product of acephate, is classified as very highly toxic to birds for oral acute, subacute dietary, dermal and inhalation exposures based on laboratory data. Acephate transforms quickly to methamidophos in the environment (dissipation time to 50% [$DT_{50}$] < 2 days); thus, methamidophos could be the main causative agent for avian mortality from acephate applications. Many field studies show that adverse effects from acephate do not occur at the time of application; rather, they occur at one to two days after application. As a result, researchers interpreted that toxicity was due to the transformation product, methamidophos. Field studies have indicated that there is a high acute risk to birds. Data from field studies suggested that when acephate alone was applied, both acephate and methamidophos were found in animals and in their food items. Birds have been shown to have marked brain cholinesterase (ChE) inhibition for at least up to 33 days after acephate application at a rate as low as 560 g a.i./ha.

As acephate transforms quickly ($DT_{50}$<2 days) to methamidophos, which is more toxic than acephate, the risk assessment is based on a consideration that acephate application is an equivalent of 50% of methamidophos. Therefore, application rates were recalculated from acephate to methamidophos based on molecular ratio of 0.77 and methamidophos toxicity endpoints were used to determine the risk. Assessment of risk of acephate plus methamidophos indicated potential risk to birds and mammals feeding on the treated field, but very few exceedances of the LOC risk when feeding adjacent to the treated field (Tables 7, 8, 9 and 10, Appendix IX). The assessment is considered to be conservative and assumed 100% of the food consumed is contaminated. The potential risk is expected to be lower as birds and mammals would not typically forage on a single food source.

### 4.2.2 Risks to Aquatic Organisms

A summary of aquatic toxicity data for acephate is presented in Table 2 (Appendix IX). For the assessment of risk, toxicity endpoints chosen from the most sensitive species were used as surrogates for the wide range of species that can be potentially exposed following treatment with acephate.

The risk assessment indicates that there is a potential chronic risk to aquatic invertebrates from acephate alone, but it is not a concern (RQ 1.1) (Table 5, Appendix IX). However, methamidophos, the major transformation product of acephate is more toxic. It is very highly toxic to aquatic invertebrates ($LC_{50}$ < 0.1 mg a.i./L), slightly toxic to freshwater fish on an acute basis ($LD_{50}$ = 10–100 mg a.i./kg), and moderately toxic to estuarine/marine organisms ($LC_{50}$ = 1-10 mg a.i./kg).

As acephate transforms quickly to methamidophos, and being more toxic than acephate, the risk assessment has been based on the assumption that acephate application is an equivalent of 50% of methamidophos. Therefore, application rates were recalculated from acephate to methamidophos based on molecular ratio of 0.77 and methamidophos toxicity endpoints were used to determine the potential risk. The results showed that there was acute risk to freshwater invertebrates and negligible risk to fish, amphibians and marine invertebrates (Table 6, Appendix IX). To protect freshwater invertebrates buffer zones should be observed (Appendix XI - Direction of Use)

### 4.3 Incident Reports

Environmental incident reports are obtained from two main sources, the Canadian pesticide incident reporting system (including both mandatory reporting from the registrant and voluntary reporting from the public and other government departments) and the USEPA Ecological Incident Information System (EIIS). Specific information regarding the mandatory reporting system regulations that came into force 26 April 2007 under the PCP Act can be found at http://www.hc-sc.gc.ca/cps-spc/pest/part/protect-proteger/incident/index-eng.php.

As of April 2015, there are no Canadian incident reports for acephate and pollinators. The USEPA Ecological Incident Information System (USEPA EIIS) contains 32 incidents:

- 6 incidents with mortality of fish (species unknown), (classification: 3-unlikely, 2-possible and 1-probable)
- 12 incidents with damaged plants (ornamental, grass, shrub, almond, hibiscus, rose, peanut and pine), (classification: 1- unlikely, 6-possible, 5-probable)
- 9 incidents with bees (mortality of 148 colonies and 48 hives)
- 4 incidents with birds (mortality of 74 boat-tailed grackle; turf treatment), (classification: 1-highly probable, 1-probable, 2-unlikely)

## 5.0 Value

### 5.1 Commercial Class Products

### 5.1.1 Commercial Class Uses for Which Information on the Value of Acephate is Sought

Appendix III lists those uses of acephate that the registrant continues to support but that have risk concerns identified as a result of this re-evaluation.

The PMRA requests feedback on the availability and extent of use of pesticidal alternatives to acephate for the uses listed in Appendix III and information regarding the availability, effectiveness and extent of use of nonpesticidal pest management practices for any of the registered uses of acephate. The PMRA also requests feedback on the feasibility of the proposed mitigation measures proposed elsewhere in this document. This information will allow the PMRA to refine sustainable pest management options for the listed site and pest combinations.

### 5.2 Domestic Class Products

There are no domestic class products formulated with acephate.

### 5.3 Value of Acephate

#### 5.3.1 Acephate Contributes to Pest Management in Canadian Food Crops

For some uses of acephate, there are limited alternative active ingredients, or few other pest management options for the purpose of managing insect resistance. Table 5.3.1 lists the uses of acephate identified by the PMRA as having a limited number of alternative active ingredients (a.i.) or that were registered through the URMULE process.

**Table 5.3.1 Registered uses of acephate identified as having a limited number of registered alternative active ingredients for the control of insect pests, and those that were registered through the URMULE process as of June 11, 2015.**

| Crop | Pest | MoA:[1] Registered alternatives[2] | Comments |
|---|---|---|---|
| Celery | Aphids | 1B: dimethoate, malathion<br>2A: endosulfan<br>4: acetamiprid, imidacloprid, thiamethoxam<br>4C: sulfoxaflor<br>9B: pymetrozine<br>9C: flonicamid<br>23: spirotetramat<br>28: cyantraniliprole<br>Other: insecticidal soap, insecticidal soap/pyrethrins | **This use of acephate was registered through the URMULE process and is identified by growers as important for crop production; the data supporting the URMULE uses were originally generated by user groups.**<br>Dimethoate is currently under re-evaluation.<br>Imidacloprid and thiamethoxam are currently under re-evaluation.<br>Endosulfan is to be phased out for use on celery by December 31, 2016, as published in REV2011-01 *Discontinuation of Endosulfan*.<br>Due to the short residual activity and the potential for phytotoxicity from repeated applications, insecticidal soap is not considered a viable alternative. |
| Celery | Tarnished plant bug | 1A: carbaryl<br>2A: endosulfan<br>3A: lambda-cyhalothrin | **There are a limited number of alternative active ingredients and all are under reevaluation.**<br>Endosulfan is to be phased out for use on celery by December 31, 2016, as published in REV2011-01 *Discontinuation of Endosulfan*. |
| Cranberry | Blackheaded fireworm | 1A: carbaryl<br>1B: diazinon, malathion, phosmet<br>5: spinosad<br>18: methoxyfenozide, tebufenozide<br>28: chlorantraniliprole | **This use of acephate was registered through the URMULE process and is identified by growers as important for crop production; the data supporting the URMULE uses were originally generated by user groups.**<br>Carbaryl and phosmet are currently under re-evaluation.<br>Foliar applications of diazinon to cranberry are to be phased out as published in RVD2009-18 *Diazinon*. |

| Crop | Pest | MoA:[1] Registered alternatives[2] | Comments |
|---|---|---|---|
| Pepper | Pepper maggot | 1B: dimethoate, malathion<br>2A: endosulfan | **There are a limited number of alternative active ingredients and dimethoate is under re-evaluation.**<br>Endosulfan is to be phased out for use on pepper by December 31, 2016, as published in REV2011-01 *Discontinuation of Endosulfan*. |
| Saskatoon berry | Woolly elm aphid | 4: imidacloprid (suppression only), acetamiprid<br>23: spirotetramat<br>Other: insecticidal soap | **These uses of acephate were registered through the URMULE process and are identified by growers as important for crop production; the data supporting these URMULE uses were originally generated by user groups.**<br>Imidacloprid is currently under re-evaluation.<br>Due to the short residual activity and the potential for phytotoxicity from repeated applications, insecticidal soap is not considered a viable alternative. |
|  | Woolly apple aphid |  |  |
| Tomato | Root maggot | None | **There are no registered alternative active ingredients to acephate for root maggot and wireworms**<br>Clothianidin, imidacloprid and thiamethoxam are currently under re-evaluation.<br>Acephate is registered for use as a transplant water application which provides protection for 2 to 3 weeks when plants are most susceptible to damage. |
|  | Thrips | 4: clothianidin/imidacloprid (seed treatment)<br>4/28: thiamethoxam/cyantraniliprole |  |
|  | Wireworm | None |  |
| Roses (greenhouse) | Rose midge | None | **There are no registered alternative active ingredients to acephate.** |
|  | Omnivorous leafroller | 11: *Bacillus thuringiensis* var *kurstaki* | **Resistance management is a concern since *Bacillus thuringiensis* is the only registered alternative to acephate.** |

[1] *Insecticide and Acaricide Resistance Management Group Numbers based on DIR 99-06 Voluntary Pesticide Resistance Management Labelling based on Target Site/Mode of Action*, with updates from the Insecticide Resistance Action Committee (IRAC) Mode of Action Classification scheme v7.2 February 2012: http://www.irac-online.org
1A = acetylcholinesterase inhibitors; 1B = acetylcholinesterase inhibitors; 2A = gamma-aminobutyric acid (GABA)-gated chloride channel antagonists; 3 = sodium channel modulators; 4 = acetylcholine receptor agonists/antagonists; 4B = acetylcholine receptor agonists; 5 = acetylcholine receptor modulators; 9 = compounds of unknown or non-specific site of action (feeding disruptors); 11 = microbial disruptors of insect mid-gut membranes; 18 = ecdysone agonist/disruptor; 23 = inhibitors of acetyl CoA carboxylase; and 28 = ryanodine receptor modulators.

[2] This is a list of registered options only as of February 15, 2012, based upon the PMRA's electronic Pesticide Regulatory System (e-PRS) database. Health Canada does not endorse any of the options listed. The registration status of active ingredients under re-evaluation may change pending the final regulatory decision. For additional information, consult the PMRA publications website: http://www.hc-sc.gc.ca/cps-spc/pubs/pest/_decisions/index-eng.php#rvd-drv (English) and http://www.hc-sc.gc.ca/cps-spc/pubs/pest/_decisions/index-fra.php (French) for Re-evaluation decisions (RVD and RRD documents) and Re-evaluation notes (REV documents) or http://www.hc-sc.gc.ca/cps-spc/pest/part/consultations/index-eng.php (English) and http://www.hc-sc.gc.ca/cps-spc/pest/part/consultations/index-fra.php (French) for current and past consultation documents including Proposed Re-evaluation Decisions (PRVD and PACR documents) and certain Re-evaluation notes (REV documents).

### 5.3.2 Acephate Contributes to Pest Management in Canadian Ornamental Crops

Acephate has a large registered use pattern on ornamentals. Producers typically grow a wide range of ornamental crops in one production area and as a result require pest control products that are registered for use on a wide range of ornamental crops. Additionally, acephate is registered for the control of a wide range of insect pests. Acephate is of particular value for the control of insects which are uncommon or sporadic in nature as there frequently are few, if any, alternative active ingredients to acephate registered to control these pests.

Acephate is registered for use on a wide variety of trees using several application methods, including foliar sprays, implant cartridges and trunk injection. Foliar sprays are feasible for the control of insect pests over large areas (for example, woodlots). The cartridge implant and trunk injection application methods are of value for applying acephate on high value trees where foliar spray applications are not feasible. This is of particular value for controlling insect pests on high value trees in urban areas, or trees close to ecologically sensitive habitats. Additionally, cartridge implants provide protection for a period of 10 to 12 weeks for heavy infestations and up to 18 weeks for light infestations, replacing the need for several foliar applications.

### 5.3.3 Use of Acephate May Avoid Repeated Applications of Non-Systemic And Contact Insecticides

Acephate is a systemic insecticide with long lasting residual activity (typically 10 to 21 days). The active ingredient is absorbed and transported throughout the plant, imparting protection to the whole plant. Once absorbed, acephate is metabolized into yet another insecticide (methamidophos). This protects the crop from insect damage until methamidophos is further metabolized by the host plants into nonpesticidal molecules. Acephate's systemic residual activity is not affected by weather (for example, rain) since it is absorbed by the host plant and cannot be washed off.

Acephate's characteristics provide advantages to growers by reducing the number of applications required while allowing greater flexibility for application timing. Systemic insecticides have a larger window of application timing than contact insecticides and nonsystemic insecticides for the control of pests that feed within the host (for example, European corn borer), since they are effective even after the pest has entered the host. Applications of contact insecticides and nonsystemic insecticides must be timed precisely to target the majority of the pest population prior to entry into their hosts. To achieve this, repeated applications of contact and nonsystemic insecticides may be required. Acephate's prolonged residual systemic activity is of particular benefit to growers when insect pests emerge over extended periods of time such as due to cool weather, or when insect pest populations remain at economically damaging levels for long periods due to overlapping generations.

# 6.0 Pest Control Product Policy Considerations

## 6.1 Toxic Substances Management Policy Considerations

The Toxic Substances Management Policy (TSMP) is a federal government policy developed to provide direction on the management of substances of concern that are released into the environment. The TSMP calls for the virtual elimination of Track 1 substances (those that meet all four criteria outlined in the policy, for example, persistent (in air, soil, water and/or sediment), bioaccumulative, primarily a result of human activity and toxic as defined by the Canadian Environmental Protection Act (CEPA).

During the review process, acephate and its transformation products were assessed in accordance with the PMRA Regulatory Directive DIR99-03[5] and evaluated against the Track 1 criteria. The PMRA has reached the following conclusions:

- Acephate does not meet Track 1 criteria, and is not considered a Track 1 substance. See Table 11, Appendix IX for comparison with Track 1 criteria.
- Acephate does not form any transformation products that meet all Track 1 criteria.

## 6.2 Formulants and Contaminants of Health or Environmental Concern

During the review process, contaminants in the technical are compared against the list in the *Canada Gazette*. The list is used as described in the PMRA Notice of Intent NOI2005-01[6] and is based on existing policies and regulations including: DIR99-03, and DIR2006-02[7], and taking into consideration the Ozone-depleting Substance Regulations, 1998, of the *Canadian Environmental Protection Act* (substances designated under the Montreal Protocol). The PMRA has reached the following conclusions:

- Technical grade acephate and the end-use products do not contain any formulants or contaminants of health or environmental concern identified in the *Canada Gazette*.

The use of formulants in registered pest control products is assessed on an ongoing basis through PMRA formulant initiatives and Regulatory Directive DIR2006-02.

# 7.0 Organisation for Economic Co-operation and Development Status of Acephate

Canada is part of the Organisation for Economic Co-operation and Development (OECD), which provides a forum in which governments can work together to share experiences and seek solutions to common problems.

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[5] DIR99-03, *The Pest Management Regulatory Agency's Strategy for Implementing the Toxic Substances Management Policy*

[6] NOI2005-01, *List of Pest Control Product Formulants and Contaminants of Health or Environmental Concern under the New Pest Control Products Act.*

[7] DIR2006-02, PMRA Formulants Policy.

As part of the reevaluation of an active ingredient, the PMRA takes into consideration recent developments and new information on the status of an active ingredient in other jurisdictions, including OECD member countries.

Acephate is currently registered for use in other OECD countries, including the United States, Australia and New Zealand.

In 2003, the European Commission prohibited the use of acephate in European Member states (made up of OECD countries). The European Commission identified concerns with regard to the safety of consumers (exposure through consumption of residues in food) and possible impacts on non-target organisms (PMRA#s. 2406720, 2406780).

The PMRA has considered exposure through consumption of residues in food (Section 3.3) and risk to nontarget organisms (Section 4.2) and is proposing several risk reduction measures to minimize human and environmental exposure (Section 9.1).

Pursuant to subsection 17(2) of the *Pest Control Products Act*, the PMRA has also initiated a special review of pest control products containing acephate based on the 2003 European Commission decision (REV2013-06). The PMRA will publish its proposed special review decision once completed.

As of 18 March, 2014, no other decision by an OECD Member country to prohibit all uses of acephate has been identified.

# 8.0 Summary

## 8.1 Human Health and Safety

The toxicology database submitted for acephate is adequate to define the majority of toxic effects that may result from exposure. Acephate is unlikely to pose a carcinogenic risk to humans. There was no evidence of birth defects in animals receiving acephate. Acephate is neurotoxic, but increased susceptibility of the young to cholinesterase inhibition was not identified in any of the comparative cholinesterase assays. In short-term and chronic toxicity studies on laboratory animals, the primary targets were cholinesterase activity and the liver at higher dose levels. The risk assessment with revised mitigation measures protects against the toxic effects noted above by ensuring that the level of human exposure is well below the lowest dose at which these effects occurred in animal tests.

### 8.1.1 Occupational Risk

For occupational handler exposure, extensive mitigation is required for most uses when using the soluble powder formulation. To keep mitigation measures feasible for all uses, the PMRA proposes that the soluble powder formulation be cancelled and that the registrant apply for the registration of additional uses to the currently registered pellet formulation.

For workers entering treated agricultural sites, most current label REIs would need to be updated in order to achieve exposure levels that meet the target MOE or ARI. Calculated REIs ranged from 12 hours to 27 days for outdoor uses. Most of the proposed REIs are agronomically feasible. However, certain REIs, in particular, outdoor cut flowers including cut roses (11-day REI) and greenhouse cut flowers including cut roses (2-day REI) are not considered agronomically feasible. The PMRA encourages stakeholders to provide feedback on these scenarios.

### 8.1.2 Dietary Risk from Food

The dietary risk assessments demonstrated that there were no acute and chronic risk concerns from exposure to food alone for any population subgroups, including infants, children, teenagers, adults and seniors.

### 8.1.3 NonOccupational Risk

The residential risk assessment indicates exposure may be of concern when a foliar treatment is applied to trees and ornamentals in residential areas. There are no domestic class products registered; however, commercial products can be applied in residential areas. To mitigate risk, a restriction on the foliar application of acephate in residential areas is proposed. The tree injection method of application is not of concern.

### 8.1.4 Aggregate Risk (Food and Water)

#### Aggregate Food and Drinking Water Risk

The aggregate chronic risk assessments demonstrated that there were no risk concerns from exposure to food and drinking water for any population subgroups, including infants, children, teenagers, adults and seniors.

Aggregate acute risk concerns were identified from food and drinking water based on initial drinking water model estimates. However, with the inclusion of mitigation measures and refinements to the drinking water model estimates, the aggregate acute risk assessment demonstrated no risk concerns for any population groups.

The mitigation measures considered include the phase-out of potato use, and the reduction of application rates, number of applications per season, and increasing application intervals for several crop uses.

#### Combined Aggregate Food and Drinking Water Risk

The combined chronic aggregate risk (for example, chronic exposure to both acephate and methamidophos from food and drinking water), based on initial drinking water modelled estimates, was of concern for infants. However, with the inclusion of mitigation measures and refinements to the drinking water model estimates, the ARI was not of concern for any population groups.

The combined acute aggregate risk could not be determined for acephate and methamidophos due to constraints in comparing the toxicological database of both compounds.

### Combined Aggregate Food, Drinking Water and Residential Risk

There is potential exposure from acephate foliar application to trees and ornamentals by commercial applicators in residential areas, which could co-occur with dietary exposure from food and drinking water. However, since foliar application to trees and ornamentals in residential areas is of concern, exposure from this use was not aggregated with exposure from food and drinking water. A label restriction is proposed to not permit foliar applications in residential areas.

## 8.2 Environmental Risk

The risk assessment of acephate and its transformation product methamidophos indicates adverse effects on nontarget terrestrial organisms (bees, beneficial insects, birds and mammals) and aquatic invertebrates. There is a potential for acephate to appear in surface water as a result of drift and/or runoff. To reduce the effects of acephate and methamidophos on the environment, mitigation in the form of precautionary label statements, limitations on application before and during bloom to reduce pollinator exposure, and buffer zones are required.

## 8.3 Value

Acephate is a systemic organophosphate insecticide (resistance Mode of Action (MoA) group 1B), with long lasting residual activity (10 to 21 days). Acephate is used to control a broad range of insect pests on a wide variety of sites and contributes to pest management in Canadian forestry, food, feed and ornamental crops.

For some uses of acephate, there are limited alternative active ingredients, or few other pest management options for the purpose of managing insecticide resistance. Food crops with uses of acephate identified as having value for pest management include celery, cranberry, pepper, Saskatoon berry, tobacco and tomato.

Acephate has value for pest management on ornamentals since it controls a broad spectrum of insect pests, on a wide range of ornamentals. This is of particular value for the control of pests which are uncommon, or sporadic in nature as there frequently are few, if any, alternative active ingredients to acephate registered to control these pests. Also, producers typically grow a wide range of ornamental crops in one production area and as a result require pest control products that are registered for use on a wide range of ornamental crops.

Acephate is registered for use on a wide variety of trees using a variety of application methods. Foliar sprays are feasible for the control of insect pests over large areas while the cartridge implant and trunk injection application methods are of value for applying acephate on high value trees where foliar sprays are not feasible such as in urban areas, or trees close to ecologically sensitive habitats. Additionally, cartridge implants provide protection for a period of 10 to 12 weeks for heavy infestations and up to 18 weeks for light infestations, replacing the need for several foliar applications.

Acephate's systemic activity combined with its long lasting residual activity provides advantages to growers by reducing the number of applications required while allowing greater flexibility for application timing.

## 9.0 Proposed Regulatory Decision

After a reevaluation of acephate, Health Canada's PMRA, under the authority of the *Pest Control Products Act*, is proposing continued registration of acephate and associated end-use products for certain uses supported by the technical registrant, provided that the mitigation measures for the health and the environment described in this document are implemented.

### 9.1 Proposed Regulatory Action

### 9.1.1 Proposed Regulatory Action Related to Human Health

For dietary exposure, risks of concern were identified based on the current use pattern for acephate. Extensive risk mitigation is proposed for continuing registration of acephate, including phase-out for use on potatoes, reduction in application rates, maximum number of applications per year, and increases in application intervals for several crops as listed in Section 9.1.1.5.

The PMRA has identified a health risk concern for residential foliar uses of acephate. Therefore, PMRA is proposing a label restriction to prohibit foliar application of commercial class products in residential areas.

The PMRA has determined that most worker risks during mixing/loading and application are not of concern, provided that the soluble powder formulation is cancelled and that the registrant obtains registration of additional uses to the pellet formulation.

For postapplication workers, some risks of concerns were identified. All possible mitigation at this time was considered. The proposed REIs for most crops may be agronomically feasible. However, REIs are not agronomically feasible for cut flowers including cut roses (indoors and outdoors) (see Section 9.1.1.4).

#### 9.1.1.1 Toxicology Information

Labels of pesticide products carry statements regarding symptoms of poisoning and treatment, which are especially important for those who may be overexposed when working with the product in a commercial or industrial setting (for example, mixers/loaders who handle more concentrated forms). Based on the toxicological assessments, the label text of the acephate containing products should be expanded and/or standardized, as noted in Appendix XI.

#### 9.1.1.2 Residue Definition for Risk Assessment and Enforcement

The current residue definition for risk assessment, in both plants and animals, is acephate and methamidophos. No revisions to the residue definition for the risk assessment are required.

For enforcement, separate MRLs are currently listed for acephate and methamidophos. Methamidophos MRLs were previously established for methamidophos, which was a pesticide registered for use in Canada. As all methamidophos uses are being phased out, the MRLs for methamidophos will be modified to account for acephate uses. Therefore, the residue definition for acephate for enforcement purpose will be acephate and methamidophos, with individual MRLs listed for each compound to account for the continued uses of acephate.

#### 9.1.1.3 Maximum Residue Limits for Acephate in Food

In general, when the re-evaluation of a pesticide has been completed, the PMRA intends to update Canadian maximum residue limits and to remove MRLs that are no longer supported. The PMRA recognizes, however, that interested parties may want to retain an MRL in the absence of a Canadian registration to allow legal importation of treated commodities into Canada. The PMRA requires similar chemistry and toxicology data for such import MRLs as those required to support Canadian food use registrations. In addition, the PMRA requires residue data that are representative of use conditions in exporting countries, in the same manner that representative residue data are required to support domestic use of the pesticide. These requirements are necessary so that the PMRA may determine whether the requested MRLs are needed and to ensure they would not result in unacceptable health risks.

After the revocation of an MRL, or where no specific MRL for a pest control product has been established under the *Pest Control Products Act*, subsection B.15.002(1) of the *Food and Drugs Act* applies. This requires that residues do not exceed 0.1 ppm and has been considered a general MRL for enforcement purposes. However, changes to this general MRL may be implemented in the future, as indicated in Discussion Document *DIS2006-01 Revocation of 0.1 ppm as a General Maximum Residue Limit for Food Pesticide Residues [Regulation B.15.002(1)]*.

As indicated in Table 9.1.1.3 the *Food and Drug Regulations* specify MRLs for acephate and methamidophos on a variety of different commodities. Residues in all other agricultural commodities, including those approved for treatment in Canada, but without a specified MRL, must not exceed the general MRL of 0.1 ppm. Parties interested in supporting MRLs for acephate and methamidophos should contact the PMRA to discuss the data requirements and relevant submission process.

Several MRL changes are proposed as a result of the reevaluation, these proposals are indicated in Table 9.1.1.3. The changes to the MRLs are proposed to account for the phase-out of all methamidophos uses, to reflect the current registered use pattern for acephate, to account for proposed mitigation measures, and to ensure that residues in food do not pose any health risk concerns. Protection of the Canadian food supply from unauthorized pesticide residues of acephate and methamidophos is the primary objective of these amendments.

**Table 9.1.1.3 Acephate and Methamidophos MRLs for Commodities Approved for Treatment in Canada and for Import Commodities with Specified MRLs**

| Commodity | ACP MRL (ppm) | MOM MRL (ppm) | Proposed MRL Change | |
|---|---|---|---|---|
| | | | ACP | MOM |
| Beans[1] | 1.0 | 0.3 | Change to Dry Beans | Change to Dry Beans |
| Broccoli | -* | 1.0 | – | Revoke MRL |
| Brussels Sprout | 1.5 | 1.0 | – | – |
| Cabbages | 0.3 | 0.5 | – | – |
| Cauliflowers | 2.0 | 0.5 | – | – |
| Celery | 5.0 | 0.5 | – | – |
| Corn | 0.5 | -* | Change to Sweet Corn Kernels plus Cob with Husks | – |
| Cranberries | 0.5 | -* | – | – |
| Cucumbers | -* | 0.5 | – | Revoke MRL |
| Eggplants | -* | 0.5 | – | Revoke MRL |
| Lettuce | 1.0 | 1.0 | Change to Head Lettuce | Change to Head Lettuce |
| Milk | 0.05 | -* | – | – |
| Peppers | 2.0 | 1.0 | – | – |
| Potatoes | 0.5 | 0.1 | Revoke MRL | Revoke MRL |
| Saskatoon berries (juneberries) | 0.03 | -* | – | – |
| Soybeans | 0.5 | -* | – | – |
| Tomatoes[2] | -* | 0.5 | – | Revoke MRL |

ACP = acephate. MOM = methamidophos.

-* = Regulated under Subsection B.15.002 (1) of the *Food and Drugs Act*. This requires that residues do not exceed 0.1 ppm and has been considered a general MRL for enforcement purposes.

[1] For import purposes

[2] Residues of methamidophos may potentially be present in tomatoes due to acephate use on tomatoes during transplanting. However, the residue level is expected to be low and below the general MRL of 0.1 ppm.

For supplemental MRL information regarding the international situation and trade implications, refer to Appendix VIII.

#### 9.1.1.4 Proposed Mitigation for Mixer, Loader, and Applicator Exposure, Postapplication Exposure and Residential Exposure

To protect workers handling acephate, the following measures are proposed:

- Cancellation of the commercial class product formulated as soluble powder, add most of the remaining uses from the label of the soluble powder product to the pellet product label. Note: The registrant of the pellet product needs to submit an application to amend the product label.

**Residential Use**

A label statement is proposed prohibiting foliar use of commercial class products in residential areas (Appendix XI).

**Agricultural Use**

The proposed REIs for the use of acephate on cut flowers, including cut roses (greenhouse and outdoor), are not agronomically feasible. Therefore, the use of acephate on greenhouse and outdoor cut flowers including cut roses are proposed to be phased out.

**Engineering Controls and Personal Protective Equipment**

Label statements are proposed to include appropriate engineering controls and personal protective equipment for various use scenarios in order to mitigate the risk of worker exposure to acephate (see Appendix XI).

**Restricted-entry Intervals**

Based on the postapplication risk to workers, new REIs have been proposed (see Appendix XI).

**Use Precautions**

To mitigate exposures to handlers, a label statement is proposed prohibiting application by handheld mist blowers and handheld foggers (Appendix XI).

Additional label statements such as best management practices to protect bystanders from exposure and restriction to certain uses are outlined in Appendix XI.

#### 9.1.1.5 Proposed Mitigation for Dietary and Drinking Water Concerns

THE FOLLOWING MITIGATION MEASURES ARE REQUIRED WHEN THE REMAINING USES FROM THE SOLUBLE POWDER LABEL ARE ADDED TO THE PELLET PRODUCT LABEL.

To mitigate risk from food and drinking water, the following measures are proposed:

- Potato:
    - Phase-out all uses
- Bell peppers:
    - Reduce maximum applications per year to 2 from 4.
    - Increase minimum application interval to 14 days from 7 days.
- Brussels sprouts, cabbage, cauliflower, head lettuce, celery, sweet and seed corn:
    - Reduce maximum application rate to 0.56 kg a.i./ha from 0.56-0.83 kg a.i./ha
    - Reduce maximum applications per year to 2 from 4.
    - Increase minimum application interval to 14 days from 7 days.

### 9.1.2 Proposed Regulatory Action Related to Environment

The risk assessment indicates that adverse effects on non-target terrestrial and aquatic organisms are expected. To reduce the effects of acephate in the environment, mitigation in the form of precautionary label statements and buffer zones are required. The risk assessment also indicated that adverse effects to pollinators are expected from contact and oral exposure. To reduce exposure of pollinators to acephate, application restrictions are required. Environmental mitigation statements are listed in Appendix XI.

## 9.2 Additional Data Requirements

There are no additional data required under section 12 of the *Pest Control Products Act*.

If the registrant wishes to remove certain proposed label restrictions the following data may be submitted during the consultation period:

- Mixer/ loader/applicator: Passive dosimetry and/or monitoring data for workers using handheld mist blowers in greenhouses.
- Mixer/loader/applicator: Passive dosimetry and/or monitoring data for workers using handheld foggers in greenhouses.
- Air concentration Study: Post application air concentration study for fogger use in greenhouses.

The following additional data may help to refine the risk assessment:

- Data to estimate exposure to postapplication workers conducting tasks with indoor and outdoor cut flowers. These data may refine the risk assessment for REIs that may not be agronomically feasible. Such data include, but are not limited to, dislodgeable foliar residue studies, passive dosimetry studies, or biological monitoring studies for this specific worker population.

## List of Abbreviations

| | |
|---|---|
| ↓ | decrease |
| ↑ | increase |
| °C | degree(s) Celsius |
| ♂ | male |
| ♀ | female |
| λ | wavelength(s) |
| 1/n | exponent for the Freundlich isotherm |
| ACP | acephate |
| ADME | absorption, distribution, metabolism and excretion |
| ADI | acceptable daily intake |
| a.i. | active ingredient |
| ARfD | acute reference dose |
| ARI | aggregate risk index |
| ARTF | agricultural re-entry task force |
| ASAE | American society of agricultural engineers |
| Atm | atmosphere |
| BAF | bioaccumulation factor |
| BCF | bioconcentration factor |
| BChE | brain cholinesterase |
| $BMDL_{10}$ | lower confidence limit on the bench mark dose associated with a 10% response |
| BUN | blood urea nitrogen |
| bw | body weight |
| CAF | composite assessment factor |
| CAS | Chemical Abstract Service |
| CEPA | *Canadian Environmental Protection Act* |
| CFIA | Canadian Food Inspection Agency |
| ChE | cholinesterase |
| cm | centimeter |
| $cm^3$ | cubic centimetre (s) |
| d | day(s) |
| DA | dermal absorption |
| DACO | data code |
| DBH | diameter at breast height |
| DEEM-FCID | dietary exposure evaluation model–food consumption intake database |
| DIR | Regulatory Directive |
| DFR | dislodgeable foliar residue |
| DMTP | O,S-dimethyl phosphorothioate |
| $DT_{50}$ | dissipation time 50% (the time required to observe a 50% decline in concentration) |
| e-PRS | electronic pesticide regulatory system database |
| EAB | emerald ash borer |
| EC | engineering controls |
| $EC_{50}$ | exposure concentration to 50% of the population |
| EChE | erythrocyte cholinesterase |
| EDE | estimated daily exposure |

| | |
|---|---|
| EEC | estimated environmental exposure concentration |
| EP | end use product |
| F0 | parental generation |
| F1 | first filial generation |
| F2 | second filial generation |
| g | gram |
| GABA | gamma-aminobutyric acid |
| GI | gastrointestinal |
| Hr (s) | hour(s) |
| ha | hectare |
| IDS | incident data system |
| IRAC | insect resistance action committee |
| IRED | interim reregistration eligibility |
| IUPAC | international union of pure and applied chemistry |
| kg | kilogram |
| $K_F$ | Freundlich adsorption coefficient |
| $K_{oc}$ | organic-carbon partition coefficient |
| $K_{ow}$ | octanol-water partition coefficient |
| L | litre |
| $LC_{50}$ | lethal concentration 50% |
| $LD_{50}$ | lethal dose 50% |
| LEACHM | leaching estimation and chemistry model |
| LOAEC | lowest observed adverse effect concentration |
| LOC | level of concern |
| LOAEL | lowest observed adverse effect level |
| LOEC | lowest observed effect concentration |
| LPM | litres per minute |
| m | metre |
| $m^3$ | cubic metre (s) |
| mg | milligram |
| mL | millilitre |
| mm | millimetre(s) |
| mm Hg | millimetres of mercury |
| mPa | milliPascal(s) |
| MoA | mode of action |
| MOE | margin of exposure |
| MOM | methamidophos |
| MRL | maximum residue limit |
| MTD | Maximum tolerated dose |
| N/A | not applicable |
| NIOSH | the national institute of occupational safety and health |
| nm | nanometre(s) |
| NOAEC | no observed adverse effect concentration |
| NOAEL | no observed adverse effect level |
| NOEC | no observed effect concentration |
| NOEL | no observed effect level |
| P | parental generation |
| Pa | Pascal |

| | |
|---|---|
| PACR | proposed acceptability for continuing registration document |
| PCA | percent crop area |
| PChE | plasma cholinesterase |
| PDP | pesticide data program |
| pH | –log10 hydrogen ion concentration |
| PHED | pesticide handlers exposure database |
| PHI | pre-harvest interval |
| pKa | dissociation constant |
| PMRA | Pest Management Regulatory Agency |
| PND | postnatal day |
| PPE | personal protective equipment |
| ppm | parts per million |
| PRVD | proposed re-evaluation decision document |
| PRZM/EXAMS | pesticide root zone model/ exposure analysis modelling system |
| RBC | red blood cells |
| REI | restricted-entry intervals |
| REV | re-evaluation note |
| RQ | risk quotient |
| RVD | re-evaluation decision document |
| SMPAA | 0-desmethyl methamidophos |
| SMPT | s-methyl acetyl phosphoramidothioate (SMPT) |
| SOP | standard operating procedures |
| $t_{1/2}$ | half-life |
| TC | transfer coefficient |
| TGAI | technical grade active ingredient |
| TRED | interim tolerance reassessment and risk management decisions |
| TSMP | Toxic Substances Management Policy |
| UDS | unscheduled DNA synthesis |
| URMULE | user requested minor use label expansion |
| USDA | United States Department of Agriculture |
| USEPA | United States Environmental Protection Agency |
| USEPA EIIS | United States Environmental Protection Agency ecological incident information system |
| µg | micrograms |
| UV | ultraviolet |
| wk | week |

# Appendix I Products Containing Acephate that are Registered in Canada Excluding Discontinued Products or Products with a Submission for Discontinuation as of June 11, 2015, Based Upon the PMRA's Electronic Pesticide Regulatory System (e-PRS) Database.

| Registration Number | Marketing Class | Registrant Name | Product Name | Formulation Type | Guarantee |
|---|---|---|---|---|---|
| 14225 | Commercial | Arysta LifeScience North America, LLC | Orthene 75% Soluble Powder Systemic Insecticide | Soluble powder | Acephate 75% |
| 21568 | Commercial | Arysta LifeScience Corporation | Acecap 97 Systemic Insecticide Implants | Soluble powder | Acephate 0.773 g/ cartridge |
| 22109 | Technical Grade Active Ingredient | Arysta LifeScience Corporation | Orthene Technical | Soluble powder | Acephate 99.78% |
| 27917 | Technical Grade Active Ingredient | Arysta LifeScience Corporation | Acephate Technical | Soluble powder | Acephate 98.0% |
| 29499 | Commercial | Arysta LifeScience North America, LLC | Orthene 97% Pellet | Pellet | Acephate 97% |

# Appendix II Commercial Class Uses of Acephate Registered in Canada, Excluding Uses from Discontinued Products or Products with a Submission for Discontinuation as of June 11, 2015, Based Upon the PMRA's Electronic Pesticide Regulatory System (e-PRS) Database.

| Site (s) | Pest (s) | Formulation Type | Application Methods and Equipment | Application Rate (kg a.i./ha) unless otherwise stated | | Maximum Number of Applications per Year[1] | Min Interval Between Applications (days)[1] | Use is Supported by the Registrant[3] |
|---|---|---|---|---|---|---|---|---|
| | | | | Maximum Single[1] | Maximum Cumulative[2] | | | |
| Use-site Category 4: Forest and woodlots<br>Use-site Category 27: Outdoor ornamentals | | | | | | | | |
| Christmas tree plantations, farm woodlots, tree nurseries, shelter belts, right of ways, municipal parks (excluding national and provincial parks) | Aphid, armyworm: (fall, beet and yellowstriped), bagworm, cankerworm (fall and spring), casebearer, fall webworm, flower thrips, gladiolus thrips, greenhouse whitefly, gypsy moth, lace bug, leaf beetle larvae (elm and willow), leafminer, meadow spittlebug, mealybug, Nantucket pine tip moth, Oak leafshredder, obliquebanded leafroller, psyllid, pear slug (pear sawfly larva), poplar tentmaker, potato leafhopper, rose midge, sawflies (open feeders: dusky birch, blackheaded ash, redheaded pine, European pine, yellowheaded spruce sawfly), scale insect (crawlers: cottony maple, hemlock, oystershell, cottony cushion, lecanium), spider mites, sunflower moth, tent caterpillars (eastern and forest), tobacco budworm, tussock moth, yellownecked caterpillar | Soluble powder | Hydraulic sprayer, Air blast (mist blower) | 1.31 | Not stated | Not stated | Not stated | Yes |

| Site (s) | Pest (s) | Formulation Type | Application Methods and Equipment | Application Rate (kg a.i./ha) unless otherwise stated | | Maximum Number of Applications per Year[1] | Min Interval Between Applications (days)[1] | Use is Supported by the Registrant[3] |
|---|---|---|---|---|---|---|---|---|
| | | | | Maximum Single[1] | Maximum Cumulative[2] | | | |
| Use-site Category 4: Forest and woodlots<br>Use-site Category 27: Outdoor ornamentals | | | | | | | | |
| Ash | Emerald ash borer | Soluble powder | Implant cartridge | 773 mg cartridge per 10.16 cm circumference at breast height | Not stated | Not stated | 70 | Yes |
| Basswood, beech, chestnut, elm, hickory, linden, maple, oak, walnut | Elm spanworm | | | | | | | |
| Birch | Aphids (green) | | | | | | | |
| | Birch leafminer | | | | | | | |
| Elm | Aphids (woolly) | | | | | | | |
| | Elm leaf beetle larvae | | | | | | | |
| Fir | Spruce coneworm | | | | | | | |
| | Western spruce budworm | | | | | | | |
| Flowering cherry | Eastern tent caterpillar | | | | | | | |
| Maple | Maple bladdergall mite | | | | | | | |
| | Gypsy moth larvae | | | | | | | |
| Oak | Aphids (woolly) | | | | | | | |
| | Gypsy moth larvae | | | | | | | |
| | Oak leafshredder | | | | | | | |
| Pine | Aphids (woolly) | | | | | | | |
| | Pine needleminer | | | | | | | |
| | Cone maggots | | | | | | | |
| Spruce | Aphids (green and woolly) | | | | | | | |
| | Spruce coneworm | | | | | | | |
| | Western spruce budworm | | | | | | | |
| Ornamental deciduous and coniferous trees in residential areas, rural lands, farms, business and office complexes, shopping complexes, multi-family residential complexes, golf courses, airports, cemeteries, parks, ravines, playgrounds, and athletic fields | Leaf feeding insects, sap sucking insects, mites | Soluble powder | Injection:<br>BioForest Inc. EcoJect System | 2.145 kg/L of water<br>0.644g/2.5 cm DBH | Not stated | 1 per two years | 24 months<br>(730 days) | Yes,<br>Minor Use Label Expansion (URMULE) |
| | | | Injection:<br>Pipette and syringe method | 1.605 kg/L of water<br>0.642g/2.5 cm DBH | Not stated | 1 per two years | 24 months<br>(730 days) | |
| Use-site Category 4: Forest and woodlots<br>Use-site Category 27: Outdoor ornamentals | | | | | | | | |
| Shade trees, ornamentals, shelterbeds (such as cotoneaster, willow, mountain ash, and pincherry) | Pear slug (pear sawfly larvae) | Soluble powder | Hydraulic sprayer,<br>Mist blower | 0.830<br>Cut flowers<br>1.31<br>Other ornamentals and trees | Not stated<br>{1.664}<br>Cut flowers<br>{2.62}<br>Other ornamentals and trees | 2 | Not stated | Yes |

| Site (s) | Pest (s) | Formulation Type | Application Methods and Equipment | Application Rate (kg a.i./ha) unless otherwise stated |  | Maximum Number of Applications per Year[1] | Min Interval Between Applications (days)[1] | Use is Supported by the Registrant[3] |
|---|---|---|---|---|---|---|---|---|
|  |  |  |  | Maximum Single[1] | Maximum Cumulative[2] |  |  |  |
| Use-site Category 6: Greenhouse ornamentals<br>Use-site Category 27: Outdoor ornamentals |  |  |  |  |  |  |  |  |
| Roses (greenhouse) | Aphids,<br>flower thrips,<br>omnivorous leafroller,<br>rose midge,<br>whitefly | Soluble powder | Hydraulic sprayer | 0.830 | Not stated | Not stated | Not stated | Yes |
| Rose (field grown) | Aphid,<br>armyworm: (fall, beet and yellowstriped),<br>flower thrips,<br>meadow spittlebug,<br>obliquebanded leafroller,<br>rose midge,<br>tussock moth,<br>scale insect (crawlers: cottony maple, hemlock, oystershell, cottony cushion, lecanium),<br>spider mites | Soluble powder | Hydraulic sprayer,<br>Mist blower | 0.830<br>Roses grown for cut flowers<br>1.31<br>Other roses | Not stated | Not stated | 7<br>(flower thrips, scale insects and spider mites )<br>Not stated (Other pests) |  |
| Abelia,<br>forsythia,<br>fruitless mulberry,<br>laurel,<br>magnolia | Scale insect (crawlers: cottony maple, hemlock, oystershell, cottony cushion, lecanium) | Soluble powder | Hydraulic sprayer,<br>Mist blower | 0.830<br>Cut flowers<br>1.31<br>Other ornamentals and trees | Not stated | Not stated | 7 | Yes |
| Alyssum,<br>daisy | Flower thrips |  |  |  |  |  |  |  |
| bottlebrush,<br>honey locust | Spider mites (except twospotted) |  |  |  |  |  |  |  |
| Camellia | Greenhouse whitefly,<br>mealybug,<br>scale insect (crawlers: cottony maple, hemlock, oystershell, cottony cushion, lecanium),<br>spider mites (except twospotted) |  |  |  |  |  |  |  |
| Daylily | Flower thrips,<br>twospotted spider mite |  |  |  |  |  |  |  |
| Gladiolus | Flower thrips,<br>gladiolus thrips |  |  |  |  |  |  |  |
| Lantana | Greenhouse whitefly |  |  |  |  |  |  |  |
| Pachysandra,<br>phlox | Twospotted spider mite |  |  |  |  |  |  |  |
| Yew (taxus) | Mealybug |  |  |  |  |  |  |  |
| Use-site Category 6: Greenhouse ornamentals<br>Use-site Category 27: Outdoor ornamentals |  |  |  |  |  |  |  |  |
| Yucca | Flower thrips,<br>scale insect (crawlers: cottony maple, hemlock, oystershell, cottony cushion, lecanium) | Soluble powder | Hydraulic sprayer,<br>Mist blower | 0.830<br>Cut flowers | Not stated | Not stated | 7 | Yes |
| Alder | Fall webworm,<br>leafminer,<br>psyllids, |  |  | 1.31<br>Other ornamentals and |  |  | Not stated |  |

| Site (s) | Pest (s) | Formulation Type | Application Methods and Equipment | Application Rate (kg a.i./ha) unless otherwise stated | | Maximum Number of Applications per Year[1] | Min Interval Between Applications (days)[1] | Use is Supported by the Registrant[3] |
|---|---|---|---|---|---|---|---|---|
| | | | | Maximum Single[1] | Maximum Cumulative[2] | | | |
| Aspen, bloodleaf (Iresine), dusty miller, flowering almond, flowering quince, gazania, mock orange, photinia, pittosporum, tulip | Aphid | | | trees | | | | |
| Boston ivy | Potato leafhopper | | | | | | | |
| Cedar | Bagworm, gypsy moth | | | | | | | |
| Cockspur thorn | Cankerworm (spring and fall) | | | | | | | |
| Deutzia | Aphid,<br>leafminer | | | | | | | |
| Flowering plum | Aphid,<br>tent caterpillar (eastern and forest) | | | | | | | |
| Hawthorn | Aphid,<br>cankerworm (spring and fall),<br>gypsy moth,<br>tent caterpillar (eastern and forest) | | | | | | | |
| Larch | Sawflies (open feeders: redheaded pine sawfly) | | | | | | | |
| Locust | Leafminer | | | | | | | |
| Poplar | Aphid,<br>fall webworm,<br>gypsy moth,<br>poplar tentmaker,<br>tent caterpillar (eastern and forest),<br>tussock moth | | | | | | | |
| Rhododendron | Lace bug | | | | | | | |
| Silver maple | Cankerworm (spring and fall) | | | | | | | |
| Slippery elm | Casebearers | | | | | | | |
| Spirea | Aphid,<br>obliquebanded leafroller | | | | | | | |
| Staghorn sumac | Obliquebanded leafroller | | | | | | | |
| Sumac | Psyllids | | | | | | | |
| Sweet gum | Bagworm | | | | | | | |
| Use-site Category 6: Greenhouse ornamentals<br>Use-site Category 27: Outdoor ornamentals | | | | | | | | |
| Sycamore | Aphid,<br>bagworm,<br>casebearers,<br>fall webworm,<br>lace bug,<br>obliquebanded leafroller,<br>tussock moth | Soluble powder | Hydraulic sprayer,<br>Mist blower | 0.830<br>Cut flowers<br>1.31<br>Other ornamentals and trees | Not stated | Not stated | Not stated | Yes |
| Wild cherry | Tussock moth | | | | | | | |
| Arborvitae | Aphid,<br>bagworm,<br>spider mites (except twospotted) | | | | | | 7<br>(spider mites)<br>Not stated<br>(Other pests) | |

| Site (s) | Pest (s) | Formulation Type | Application Methods and Equipment | Application Rate (kg a.i./ha) unless otherwise stated | | Maximum Number of Applications per Year[1] | Min Interval Between Applications (days)[1] | Use is Supported by the Registrant[3] |
|---|---|---|---|---|---|---|---|---|
| | | | | Maximum Single[1] | Maximum Cumulative[2] | | | |
| Aster | Aphid,<br>armyworm,<br>flower thrips,<br>leafminer | | | | | | 7<br>(flower thrips)<br>Not stated<br>(Other pests) | |
| Calendula | Aphid,<br>armyworm: (fall, beet and yellowstriped),<br>flower thrips,<br>potato leafhopper,<br>tobacco budworm | | | | | | | |
| Petunia | Armyworm: (fall, beet and yellowstriped),<br>flower thrips,<br>tobacco budworm | | | | | | | |
| Snapdragon | Aphid,<br>armyworm: (fall, beet and yellowstriped),<br>flower thrips,<br>tobacco budworm | | | | | | | |
| Azalea | Aphid,<br>greenhouse whitefly,<br>lace bug,<br>mealybug,<br>scale insect (crawlers: cottony maple, hemlock, oystershell, cottony cushion, lecanium),<br>spider mites (except twospotted) | | | | | | 7<br>(greenhouse whitefly, mealybug, scale insects and spider mites)<br>Not stated<br>(Other pests) | |
| Barberry,<br>ligustrum,<br>mahonia | Aphid,<br>greenhouse whitefly | | | | | | 7<br>(greenhouse whitefly)<br>Not stated<br>(aphid) | |
| Boxwood,<br>Euonymous,<br>hibiscus,<br>nandina,<br>rose of Sharon | Aphid,<br>scale insect (crawlers: cottony maple, hemlock, oystershell, cottony cushion, lecanium) | | | | | | 7<br>(scale insects)<br>Not stated<br>(Other pests) | |
| Use-site Category 6: Greenhouse ornamentals<br>Use-site Category 27: Outdoor ornamentals | | | | | | | | |
| Cotoneaster | Aphid,<br>lace bug,<br>scale insect (crawlers: cottony maple, hemlock, oystershell, cottony cushion, lecanium) | Soluble powder | Hydraulic sprayer,<br>Mist blower | 0.830<br>Cut flowers<br>1.31<br>Other ornamentals and trees | Not stated | Not stated | 7<br>(scale insects)<br>Not stated<br>(Other pests) | Yes |
| Geranium | Tobacco budworm,<br>scale insect (crawlers: cottony maple, hemlock, oystershell, cottony cushion, lecanium) | | | | | | | |
| Hackberry | Psyllids,<br>scale insect (crawlers: cottony maple, hemlock, oystershell, cottony cushion, lecanium) | | | | | | | |
| Lilac | Aphid,<br>leafminer,<br>scale insect (crawlers: cottony maple, hemlock, oystershell, cottony cushion, lecanium) | | | | | | | |

| Site (s) | Pest (s) | Formulation Type | Application Methods and Equipment | Application Rate (kg a.i./ha) unless otherwise stated |  | Maximum Number of Applications per Year[1] | Min Interval Between Applications (days)[1] | Use is Supported by the Registrant[3] |
|---|---|---|---|---|---|---|---|---|
|  |  |  |  | Maximum Single[1] | Maximum Cumulative[2] |  |  |  |
| Pyracantha | Aphid,<br>lace bug, yellownecked caterpillar,<br>scale insect (crawlers: cottony maple, hemlock, oystershell, cottony cushion, lecanium) |  |  |  |  |  |  |  |
| Willow | Aphid,<br>bagworm,<br>willow leaf beetle (larvae),<br>fall webworm,<br>gypsy moth,<br>poplar tentmaker,<br>psyllids,<br>sawflies (open feeders: dusky birch),<br>tent caterpillar (eastern and forest),<br>tussock moth,<br>scale insect (crawlers: cottony maple, hemlock, oystershell, cottony cushion, lecanium) |  |  |  |  |  |  |  |
| Cypress | Bagworm,<br>scale insect (crawlers: cottony maple, hemlock, oystershell, cottony cushion, lecanium),<br>spider mites |  |  |  |  |  | 7<br>(scale insects, spider mites)<br>Not stated<br>(Other pests) |  |
| Use-site Category 6: Greenhouse ornamentals<br>Use-site Category 27: Outdoor ornamentals |  |  |  |  |  |  |  |  |
| Dahlia | Armyworm: (fall, beet and yellowstriped),<br>potato leafhopper,<br>twospotted spider mite | Soluble powder | Hydraulic sprayer,<br>Mist blower | 0.830<br>Cut flowers<br>1.31<br>Other ornamentals and trees | Not stated | Not stated | 7<br>(twospotted spider mite)<br>Not stated<br>(Other pests) | Yes |
| Hemlock | Gypsy moth,<br>scale insect (crawlers: cottony maple, hemlock, oystershell, cottony cushion, lecanium),<br>spider mites (except twospotted) |  |  |  |  |  | 7<br>(scale insects, spider mites)<br>Not stated<br>(Other pests) |  |
| Holly | Leafminer,<br>obliquebanded leafroller,<br>psyllids,<br>tussock moth,<br>scale insect (crawlers: cottony maple, hemlock, oystershell, cottony cushion, lecanium),<br>spider mites (except twospotted) |  |  |  |  |  |  |  |
| Hydrangea, primrose | Aphid,<br>twospotted spider mite |  |  |  |  |  | 7<br>(twospotted spider mite)<br>Not stated<br>(aphid) |  |

| Site (s) | Pest (s) | Formulation Type | Application Methods and Equipment | Application Rate (kg a.i./ha) unless otherwise stated | | Maximum Number of Applications per Year[1] | Min Interval Between Applications (days)[1] | Use is Supported by the Registrant[3] |
|---|---|---|---|---|---|---|---|---|
| | | | | Maximum Single[1] | Maximum Cumulative[2] | | | |
| Ivy | Aphid,<br>mealybug | | | | | | 7<br>(mealybugs)<br>Not stated<br>(aphid) | |
| Juniper | Bagworm,<br>meadow spittlebug,<br>spider mites (except twospotted) | | | | | | 7<br>(spider mites)<br>Not stated<br>(bagworm and spittle bug) | |
| Marigold | Flower thrips,<br>leafminer,<br>sunflower moth,<br>twospotted spider mite | | | | | | 7<br>(flower thrips, twospotted spider mite)<br>Not stated<br>(leafminer, sunflower moth) | |
| Salvia | Aphid,<br>flower thrips,<br>greenhouse whitefly | | | | | | 7<br>(flower thrips, greenhouse whitefly)<br>Not stated<br>(aphid) | |
| Use-site Category 6: Greenhouse ornamentals<br>Use-site Category 27: Outdoor ornamentals | | | | | | | | |
| Viburnum | Aphid,<br>greenhouse whitefly,<br>twospotted spider mite | Soluble powder | Hydraulic sprayer,<br>Mist blower | 0.830<br>Cut flowers<br>1.31<br>Other ornamentals and trees | Not stated | Not stated | 7<br>(greenhouse whitefly, twospotted spider mite)<br>Not stated<br>(aphid) | Yes |
| Wisteria | Aphid,<br>mealybugs,<br>scale insect (crawlers: cottony maple, hemlock, oystershell, cottony cushion, lecanium) | | | | | | 7<br>(mealybug, scale insect)<br>Not stated<br>(aphid) | |
| Zinnia | Flower thrips,<br>greenhouse whitefly,<br>lace bug,<br>leafminer | | | | | | 7<br>(flower thrips, greenhouse whitefly)<br>Not stated<br>(lace bug, leafminer) | |
| Ash | Aphid,<br>fall webworm,<br>gypsy moth,<br>lace bug, sawflies (open feeders: blackheaded ash),<br>tent caterpillar (eastern and forest),<br>tussock moth | | | | | | Not stated | |

| Site (s) | Pest (s) | Formulation Type | Application Methods and Equipment | Application Rate (kg a.i./ha) unless otherwise stated | | Maximum Number of Applications per Year[1] | Min Interval Between Applications (days)[1] | Use is Supported by the Registrant[3] |
|---|---|---|---|---|---|---|---|---|
| | | | | Maximum Single[1] | Maximum Cumulative[2] | | | |
| Birch | Aphid,<br>cankerworm (spring and fall),<br>fall webworm,<br>gypsy moth,<br>leafminer,<br>sawflies (open feeders: dusky birch),<br>tent caterpillar (eastern and forest),<br>tussock moth,<br>yellownecked caterpillar | | | | | | | |
| Elm (Chinese or Siberian) | Armyworm (fall, beet and yellowstriped) on Chinese elm only,<br>elm leaf beetle (larvae),<br>tussock moth,<br>scale insect (crawlers: cottony maple, hemlock, oystershell, cottony cushion, lecanium) on Chinese elm only | | | | | | 7 (scale insects)<br>Not stated (other pests) | |
| Use-site Category 6: Greenhouse ornamentals<br>Use-site Category 27: Outdoor ornamentals | | | | | | | | |
| Fir | Aphid,<br>tussock moth,<br>scale insect (crawlers: cottony maple, hemlock, oystershell, cottony cushion, lecanium),<br>spider mites (except twospotted) | Soluble powder | Hydraulic sprayer,<br>Mist blower | 0.830 Cut flowers<br>1.31 Other ornamentals and trees | Not stated | Not stated | 7 (scale insects, spider mites)<br>Not stated (other pests) | Yes |
| Flowering cherry | Obliquebanded leafroller,<br>tent caterpillar (eastern and forest) | | | | | | Not stated | |
| Linden | Aphid,<br>bagworm, cankerworm (spring and fall),<br>fall webworm,<br>tussock moth,<br>yellownecked caterpillar | | | | | | | |
| Maple | Aphid,<br>bagworm,<br>cankerworm (spring and fall),<br>gypsy moth,<br>potato leafhopper,<br>tent caterpillar (eastern and forest),<br>tussock moth,<br>scale insect (crawlers: cottony maple, hemlock, oystershell, cottony cushion, lecanium) | | | | | | 7 (scale insects)<br>Not stated (other pests) | |

| Site (s) | Pest (s) | Formulation Type | Application Methods and Equipment | Application Rate (kg a.i./ha) unless otherwise stated | | Maximum Number of Applications per Year[1] | Min Interval Between Applications (days)[1] | Use is Supported by the Registrant[3] |
|---|---|---|---|---|---|---|---|---|
| | | | | Maximum Single[1] | Maximum Cumulative[2] | | | |
| Oak | Aphid, cankerworm (spring and fall), fall webworm, gypsy moth, lace bug, leafminer, obliquebanded leafroller, oak leaf shredder (white and red oak only), tent caterpillar (eastern and forest), tussock moth, yellownecked caterpillar, scale insect (crawlers: cottony maple, hemlock, oystershell, cottony cushion, lecanium), spider mites (except twospotted) | | | | | | 7<br>(scale insects, spider mites)<br>Not stated<br>(other pests) | |
| Use-site Category 6: Greenhouse ornamentals<br>Use-site Category 27: Outdoor ornamentals | | | | | | | | |
| Pine | Bagworm, gypsy moth, Nantucket pine tip moth, sawflies (open feeders: redheaded pine, European pine sawfly), tussock moth, scale insect (crawlers: cottony maple, hemlock, oystershell, cottony cushion, lecanium), spider mites (except twospotted) | Soluble powder | Hydraulic sprayer, Mist blower | 0.830<br>Cut flowers<br>1.31<br>Other ornamentals and trees | Not stated | Not stated | 7<br>(scale insects, spider mites)<br>Not stated<br>(other pests) | Yes |
| Spruce | Gypsy moth, leafminer, sawflies (open feeders: redheaded pine, yellowheaded spruce sawfly), tussock moth, spider mites (except twospotted) | | | | | | | |
| Use-site Category 13: Terrestrial feed crops<br>Use-site Category 14: Terrestrial food crops | | | | | | | | |
| Corn (seed and sweet) | European corn borer | Soluble powder | Conventional ground equipment | 0.563-0.825 | {3.300} | 4 | Not stated | Yes |
| Potato | Green peach aphid, potato aphid, potato flea beetle, potato leafhopper, tarnished plant bug | Soluble powder | Conventional ground equipment | 0.563-0.825 | {3.300} | 4 | 7 | Yes |
| Tomato | Cutworms, potato flea beetle, root maggots, wireworm, aphids, thrips, Colorado potato beetle | Soluble powder | Conventional ground equipment | 0.900 | Not stated<br>{0.900} | Not stated<br>{1} | Not stated<br>{Not applicable} | Yes |
| Use-site Category 14: Terrestrial food crops | | | | | | | | |
| Brussels sprouts, cabbage, cauliflower, | Cabbage looper, imported cabbageworm, diamondback moth, green peach aphid | Soluble powder | Conventional ground equipment | 0.563-0.825 | {1.650} | 2 | Not stated | Yes |
| Head lettuce (crisp head type only) | | Soluble powder | Conventional ground equipment | 0.563-0.825 | {3.300} | 4 | Not stated | Yes |

| Site (s) | Pest (s) | Formulation Type | Application Methods and Equipment | Application Rate (kg a.i./ha) unless otherwise stated | | Maximum Number of Applications per Year[1] | Min Interval Between Applications (days)[1] | Use is Supported by the Registrant[3] |
|---|---|---|---|---|---|---|---|---|
| | | | | Maximum Single[1] | Maximum Cumulative[2] | | | |
| Celery | Green peach aphid | Soluble powder | Conventional ground equipment | 0.563-0.825 | {3.300} | 4 | Not stated | Yes,<br>User Requested Minor Use Label Expansion |
| | Tarnished plant bug | | | | | | | Yes |
| Cranberry | Blackheaded fireworm | Soluble powder | Conventional ground equipment | 0.562 | {1.124} | 2 | Not stated | Yes,<br>User Requested Minor Use Label Expansion |
| Use-site Category 14: Terrestrial food crops | | | | | | | | |
| Saskatoon berries (non-bearing) | Woolly elm aphid | Soluble powder | Soil injection | 0.637 kg/1000 L<br>0.001275 kg/plant<br>2.55 kg at 2000 plants/ha | 2.55 at 2000 plants/ha | 1 | Not applicable | Yes,<br>Minor Use Label Expansion (URMULE) |
| Saskatoon berries (bearing) | Woolly elm aphid, woolly apple aphid | | | | | | | |
| Sweet pepper (Bell type) | Green peach aphid, pepper maggot | Soluble powder | Conventional ground equipment. | 0.562 | {2.248} | 4 | 7 | Yes |
| | European corn borer | | | 0.825 | {3.300} | | | |
| Tobacco (flue cured) | Tomato hornworm, flea beetle, green peach aphid<br>(foliar spray) | Soluble powder | Conventional ground equipment. | 0.563-0.825 | Not stated<br>[1.65] | Not stated<br>[2] | 7 | Yes |
| | | Pellet | | 0.422-0.619 | 4.489 | Not stated<br>{10 at low rate<br>7 at high rate} | | |
| | Darksided cutworm<br>(pre-plant) | Soluble powder | | 0.563<br>(cover crop treatment) | Not stated<br>{0.563} | Not stated<br>{1} | Not stated<br>{Not applicable} | |
| | | | | 1.125<br>(soil treatment) | Not stated<br>{1.125} | | | |
| | | Pellet | | 0.422<br>(cover crop treatment) | Not stated<br>{0.422} | | | |
| | | | | 0.844<br>(soil treatment) | Not stated<br>{0.844} | | | |
| | Darksided cutworm<br>(post-plant) | Soluble powder | | 1.125 | Not stated<br>{1.125} | | | |
| | | Pellet | | 0.844 | Not stated<br>{0.844} | | | |
| Tobacco | Darksided cutworm, potato flea beetle, root maggots, green peach aphid, thrips<br>(transplant water treatment) | Soluble powder | Conventional ground equipment | 0.825-1.275 | Not stated<br>{1.275} | Not stated<br>{1} | Not stated<br>{Not applicable} | Yes |
| | | Pellet | | 0.619-0.956 | Not stated<br>{0.956} | | | |

| Site (s) | Pest (s) | Formulation Type | Application Methods and Equipment | Application Rate (kg a.i./ha) unless otherwise stated | | Maximum Number of Applications per Year[1] | Min Interval Between Applications (days)[1] | Use is Supported by the Registrant[3] |
|---|---|---|---|---|---|---|---|---|
| | | | | Maximum Single[1] | Maximum Cumulative[2] | | | |
| | wireworm<br>(transplant water treatment) | Soluble powder | | 0.825 | 0.825 | 1 | Not applicable | |
| | | Pellet | | 0.619 | 0.619 | | | |

[1] All information is from the registered labels except for information provided by the registrant [ ] or information added by the PMRA { }.

[2] The maximum cumulative rate calculated by the PMRA is based upon the maximum single rate (kg a.i./ha) times the maximum number of applications and is indicated by curly brackets { }.

[3] Yes = the registrant supports the use; User Requested Minor Use Label Expansion (URMULE) = the use was registered under the URMULE program.

# Appendix III Commercial Class Uses of Acephate Which are Proposed for Removal From the Registered Use Pattern in Canada, for Which the PMRA Requests Information on Value.

| Site(s)[1] | Application method | Use is Supported by the Registrant[2] |
|---|---|---|
| Use-site Category 4: Forest and woodlots<br>Use-site Category 27: Outdoor ornamentals | | |
| Shade trees, ornamentals, shelterbeds (such as cotoneaster, willow, mountain ash, and pincherry) | Ground application: hydraulic sprayer and mist blower | Yes |
| Use site Category 6: Greenhouse ornamentals<br>Use-site Category 27: Outdoor ornamentals | | |
| Abelia,<br>forsythia,<br>fruitless mulberry,<br>laurel,<br>magnolia,<br>alyssum,<br>daisy,<br>bottlebrush,<br>honey locust,<br>camellia,<br>daylily,<br>gladiolus,<br>lantana,<br>pachysandra | Ground application: hydraulic sprayer and mist blower | Yes |
| Use site Category 6: Greenhouse ornamentals<br>Use-site Category 27: Outdoor ornamentals | | |

| Site(s)[1] | Application method | Use is Supported by the Registrant[2] |
|---|---|---|
| Phlox,<br>yew (taxus),<br>yucca,<br>alder,<br>aspen,<br>bloodleaf (Iresine),<br>dusty miller,<br>flowering almond,<br>flowering quince,<br>gazania,<br>mock orange,<br>photinia,<br>pittosporum,<br>tulip,<br>Boston ivy,<br>cedar,<br>cockspur thorn,<br>deutzia,<br>flowering plum,<br>hawthorn,<br>larch,<br>locust,<br>poplar,<br>rhododendron,<br>silver maple,<br>slippery elm,<br>spirea,<br>staghorn sumac,<br>sumac,<br>sweet gum,<br>sycamore,<br>wild cherry,<br>arborvitae,<br>aster,<br>calendula,<br>petunia,<br>snapdragon,<br>azalea,<br>barberry,<br>ligustrum,<br>mahonia,<br>boxwood,<br>Euonymous,<br>hibiscus,<br>nandina,<br>rose of Sharon,<br>cotoneaster,<br>geranium,<br>hackberry,<br>lilac,<br>pyracantha,<br>willow,<br>cypress,<br>dahlia,<br>hemlock,<br>holly,<br>hydrangea,<br>primrose,<br>ivy,<br>juniper,<br>marigold | Ground application: hydraulic sprayer and mist blower | Yes |

| Site(s)[1] | Application method | Use is Supported by the Registrant[2] |
|---|---|---|
| Use site Category 6: Greenhouse ornamentals<br>Use-site Category 27: Outdoor ornamentals | | |
| Salvia,<br>viburnum,<br>wisteria,<br>zinnia,<br>ash,<br>birch,<br>elm (Chinese or Siberian),<br>fir,<br>flowering cherry,<br>linden,<br>maple,<br>oak,<br>pine,<br>spruce | Ground application: hydraulic sprayer and mist blower | Yes |
| Use-site Category 13: Terrestrial feed crops<br>Use-site Category 14: Terrestrial food crops | | |
| potato | Ground application: conventional ground equipment | Yes |
| Saskatoon berries (non-bearing),<br>Saskatoon berries (bearing) | Soil injection | |

[1] Residential ornamentals only and wettable powder formulations (ornamentals and Saskatoon berries).

[2] Yes = the registrant supports the use; User Requested Minor Use Label Expansion (URMULE) = the use was registered under the URMULE program.

# Appendix IV Toxicology Profile for Acephate Tables and Figures

## Table 1 Toxicity Profile of Technical Acephate

(Notes: Depression of PChE is not considered by PMRA to be a toxicologically adverse effect; it can be viewed as a marker of exposure. Depression of EChE can be viewed as a surrogate for adverse changes in peripheral nervous tissue in acute and some short-term studies. In studies of longer duration, depression of EChE alone is not considered by PMRA to be a toxicological adverse effect. Effects noted below are known or assumed to occur in both sexes unless otherwise specified).

| Study Type/ Animal/PMRA # | Study Results |
|---|---|
| **Toxicokinetic Studies** | |
| ADME<br>Sprague Dawley rats<br>PMRA #2141785 | Absorption: Almost completely absorbed from the GI tract.<br>Distribution: No evidence of tissue accumulation. At 72 hrs tissue recovery accounted for about 0.32% of the administered dose (liver~0.18%, skin~0.11% and ≤0.005% in brain, heart, kidney, muscle, fat and gut).<br>Metabolism: Identified urinary metabolites were primarily unchanged acephate (73-77%), o,s-dimethylphosphorothioate (DMPT) (3-6%) and s-methyl acetyl phosphoramidothioate (SMPT) (3-4%).<br>Excretion: Rapidly eliminated with most excretion in the first 6-12 hrs and mainly in the urine (urine~87-95%, feces~1%, expired air~3% in 48 hrs). |
| ADME<br>Sprague Dawley rats<br>PMRA #2057878 | Absorption: Rapid with maximum plasma concentration 0.5 hrs post-dosing.<br>Distribution: Highest concentration of radioactivity 0.5 to 1 hr post-dosing. Tissue concentration decreased by an order of magnitude or more by 24 hrs post-dosing. The highest concentrations of radioactivity 24 hrs post-dosing (% administered dose) found in liver, GI tract and GI tract contents. All other tissues contained less than 0.1% of administered dose.<br>Metabolism: Major radioactive compound identified in the urine was unmetabolized acephate (77-79%) followed by methamidophos (3.4-3.8%) and 3 other components (0.7-4.2%). The unknown components were potentially des-acetamidoacephate (DMPT), 0-desmethyl acephate (SMPT), and 0-desmethyl methamidophos (SMPAA) but due to the small amounts, they were not identified further. Fecal metabolites were also not identified due to the small identified amounts (1.7-3.0%).<br>Excretion: In both genders at both dosage levels, the urine, feces and expired carbon dioxide accounted for 82-89%, 2-3% and 5-10% of the administered dose with cage wash, tissues, GI tract and carcass each accounting for less than 3.3% of the administered dose. Most radioactivity was recovered by 24 hrs post-dosing.<br>Overall, the absorption, distribution, metabolism and excretion of radiolabeled acephate exhibited no dose or gender differences.<br>Note: A metabolic pathway was not elucidated. |
| Metabolism<br>Sprague Dawley rats<br>PMRA #1174826 | Metabolism: Three hours after final dosing, ~0.6-1.6% of the administered dose in carcass and 1.1-1.5% in excreta (chiefly urine) were converted to methamidophos mainly by the intestinal microorganisms of the rat. There was no tendency for methamidophos to accumulate in blood, liver, muscle, fat and heart. |

| Study Type/ Animal/PMRA # | Study Results |
|---|---|
| **Acute Toxicity Studies** | |
| Acute Oral Toxicity<br>Various species<br>PMRA #1207960 and 1207955 | Rat LD$_{50}$ = 866-1,494 mg/kg bw<br>Mouse LD$_{50}$ = 362-403 mg/kg bw<br>Rabbit LD$_{50}$ = 707 mg/kg bw (♂ only)<br>Hen LD$_{50}$ = 360 mg/kg bw (7 months of age), ~784 mg/kg bw (one year of age)<br>Clinical signs include tremors, diarrhea, salivation, ataxia, depression and ↓ food consumption in almost all treated animals. Bloody tears observed in most surviving animals.<br>Slight to Moderate Toxicity |
| Acute Dermal Toxicity<br>New Zealand White rabbits<br>PMRA #1207961 | LD$_{50}$ > 2,000 mg/kg bw<br>Low Toxicity |
| Acute Inhalation Toxicity<br>Sprague Dawley rats<br>PMRA #1207962 | LC$_{50}$ > 5 mg/L (actual concentration)<br>Clinical signs included transient signs of tremors, ataxia and depression.<br>Low Toxicity |
| Acute Dermal Irritation<br>New Zealand White rabbits<br>PMRA #1207964 | Minimally or mildly irritating |
| Acute Eye Irritation<br>New Zealand White rabbits<br>PMRA #1207963 | Minimally or mildly irritating |
| Dermal Sensitization<br>Guinea pigs<br>PMRA #1207965 | Non-sensitizer in Buehler patch test |
| **Short-term Toxicity Studies** | |
| 13-wk Dietary Toxicity<br>Sprague Dawley rats<br>PMRA #2141830 | LOAEL or threshold NOAEL = 0.12/0.15 mg/kg bw/day, ♂/♀<br>0.12/0.15 mg/kg bw/day (♂/♀): ↓ BChE;<br>8.9/11.5 mg/kg bw/day (♂/♀): ↓ EChE and PChE, ↑ incidence of red discharge from the eyes.<br>Note: ↓ BChE at 0.12/0.15 mg/kg bw/day was slight (<10%) but statistically significant. This dose is believed to be close to the threshold of a NOAEL due to the minimal effect. |
| 33/34-day Oral Toxicity<br>monkeys<br>PMRA #2141808 | LOAEL = 2.5 mg/kg bw/day<br>2.5 mg/kg bw/day: ↓ BChE, EChE and PChE; weight loss (♀). |

| Study Type/<br>Animal/PMRA # | Study Results |
|---|---|
| 1-year Dietary Toxicity<br>Beagle dogs<br>PMRA #2141851 | LOAEL = 0.27 mg/kg bw/day (♂)<br>0.27 mg/kg bw/day: ↓ BChE (♂);<br>≥3.11 mg/kg bw/day: ↓ EChE; ↓ BChE (♀);<br>20.2 mg/kg bw/day: ↓ PChE, ↓ haematological parameters (RBC, haemoglobin and hematocrit), ↑ thromboplastin time, ↑ liver weight and histological changes in the liver (perivascular infiltration and pigments in reticuloendothelial cells). |
| 2-year Dietary Chronic Toxicity<br>Beagle dogs<br>PMRA #1596412 and 1207991 | NOAEL = 0.75 mg/kg bw/day<br>2.5 mg/kg bw/day: ↓ BChE and EChE. |
| 3-wk Dermal Toxicity<br>New Zealand White rabbits<br>PMRA #1207952 | LOAEL = 375 mg/kg bw/day<br>≥375 mg/kg bw/day: ↓ EChE (BChE and PChE not measured), ↑ liver weight, ↓ RBC counts;<br>≥750 mg/kg bw/day: ↑ parasympathomimetric signs of poisoning, ↓ weight gain, ↓ hemoglobin and hematocrit, ↓ BUN;<br>1,500 mg/kg bw/day: mortality (2/16). |
| 3-wk Dermal Toxicity<br>Sprague Dawley rats<br>PMRA #1191836, 1118391 and 1256474 | NOAEL = 50 mg/kg bw/day<br>50 mg/kg bw/day: no mortality, no effect on BChE, no clinical signs of toxicity or significant irritation at treated skin sites reported. |
| 3-wk Dermal Toxicity<br>Sprague Dawley rats<br>PMRA #1118396 | NOAEL = 12 mg/kg bw/day<br>≥60 mg/kg bw/day: ↓ BChE (♀);<br>300 mg/kg bw/day: ↓ BChE (♂). |
| 4-wk Inhalation Toxicity<br>Sprague Dawley rats<br>PMRA #1191837 and 1256475 | NOAEL = 0.001 mg/L (0.26 mg/kg bw/day)<br>≥0.003 mg/L: ↓ EChE (day 5), ↓ PChE; ↓ BChE (♂);<br>0.005 mg/L: laboured breathing; ↓ BChE (♀). |
| **Chronic Toxicity/Carcinogenicity Studies** | |
| 2-year Dietary Chronic toxicity/ Carcinogenicity<br>CD-1 mice<br>PMRA #1208010 and 1208011 | NOAEL = 7/8 mg/kg bw/day (♂/♀)<br>≥36/42 mg/kg bw/day (♂/♀): ↓ weight gain and food consumption, ↑ hypertrophy, karyomegaly and intranuclear inclusion bodies in the liver;<br>146/167 mg/kg bw/day (♂/♀): ↑ aggressive behaviour (♂); ↑ liver weight, hepatocellular carcinomas and liver hyperplastic nodules at terminal sacrifice (♀).<br>Note: Cholinesterase activity not measured.<br>Limited evidence of carcinogenicity at level exceeding maximum tolerated dose. |
| 28-month Dietary Chronic Toxicity/ Carcinogenicity<br>Sprague Dawley rats | LOAEL = 0.24/0.31 mg/kg bw/day, ♂/♀<br>≥0.24/0.31 mg/kg bw/day (♂/♀): ↓ BChE;<br>≥2.4/3.1 mg/kg bw/day (♂/♀): ↓ EChE and PChE;<br>38/47 mg/kg bw/day (♂/♀): ↓ weight gain and food efficiency, ↑ aggressive behaviour (♂). |

| Study Type/ Animal/PMRA # | Study Results |
|---|---|
| PMRA #1207956. 1207957. 1596408. 1207980. 1207777 and 1207778 | No evidence of carcinogenicity. |
| **Neurotoxicity Studies** | |
| Acute Delayed Neurotoxicity<br>Leghorn hens<br>PMRA #1208016 | Mortality (4/24). ↓ motor activity. no neuropathological findings related to treatment. no apparent evidence of delayed neurotoxicity.<br>Note: Cholinesterase and neurotoxic esterase activities not measured. |
| Acute Delayed Neurotoxicity<br>Hens<br>PMRA #1208017 | Mortality (9/16). ↓ body weight. ↑ clinical signs (diarrhea. lethargy. weakness in lower limbs. loss of coordination. ataxia. wing droop and reduced reaction to sound and movement). no neuropathological findings related to treatment and no apparent evidence of delayed neurotoxicity.<br>Note: Cholinesterase and neurotoxic esterase activities not measured. |
| Range-finding Acute Oral Neurotoxicity<br>Sprague Dawley rats<br>PMRA #1191820 and 1256472 | NOAEL = 0.5 mg/kg bw (♀)<br>≥2.5 mg/kg bw: ↓ BChE (hippocampus. midbrain. brain stem. cerebellum and cortex) (♀);<br>≥5.0 mg/kg bw: ↓ BChE (♂);<br>≥25 mg/kg bw: ↓ EChE and PChE. tremors of the mouth (repetitive movement). twitching of both ears;<br>≥125 mg/kg bw: tremors of forelimbs/hindlimbs and whole body. altered gaits (rocking or swaying). salivation;<br>500 mg/kg bw: hypothermia (body cool to touch).<br>All clinical signs were observed at 1 or 2 hrs post-dosing and persisted until the scheduled sacrifice (2.5 hrs post-dosing). |
| Acute Oral Neurotoxicity<br>Sprague Dawley rats<br>PMRA #1256472 | LOAEL = 10 mg/kg bw<br>≥10 mg/kg bw: whole body tremors. ↓ BChE. EChE and PChE; ↓ rotarod performance (♂);<br>≥100 mg/kg bw: limb tremors. ataxia. weakness in hindlimbs and repetitive movement of mouth and jaws. alterations in posture. gait and mobility. low arousal and no approach and touch responses. ↓ rearing. motor activities and body temperature. ↑ righting reflex and time to first steps; lacrimation. salivation. soiled fur and ↓ weight gain (♂);<br>500 mg/kg bw: ↑ catalepsy time and clonic convulsions. ↓ hindlimb footsplay. forelimb and hindlimb grip strength. absence of the pinch. startle and olfactory responses. chromodacryorrhea. clear or coloured (tan. red. brown and/or yellow) staining/ matting material on various body surfaces.<br>Clinical signs occurred within 0.5 to 2.5 hrs post-dosing and were absent the next day. |
| 13-wk Dietary Neurotoxicity<br>Sprague Dawley rats<br>PMRA #1191816. 1191817 and 1256472 | LOAEL = 0.33/0.41 mg/kg bw/day ♂/♀<br>≥0.33/0.41 mg/kg bw/day (♂/♀): ↓ BChE;<br>≥3.3/3.9 mg/kg bw/day (♂/♀): ↓ PChE;<br>≥49/58 mg/kg bw/day (♂/♀): ↓ weight gain. ↓ EChE. ↑ rearing and grooming; ↓ rotarod time (♂); ↓ motor activity (♀). |

| Study Type/ Animal/PMRA # | Study Results |
|---|---|
| Acute and Repeat-dose Range-finding Cholinesterase<br><br>Sprague Dawley rats, neonatal pups<br><br>PMRA #2057876 | **Acute and Repeat-dose phases**<br>Pups used to determine dosage levels for the time-course phase of the study and were not assessed for cholinesterase activity. In these pups, no mortalities, clinical signs of toxicity, body weight effects or adverse gross necropsy findings were noted.<br><br>**Time-course phase**<br>Time-to-peak data were highly variable. With two exceptions, the time-to-peak effect ranged from 2 to 8 hrs post-dosing. Based on these results, the author selected a time-to-peak effect of 3 hrs for future studies conducted with PND11 and PND21 pups.<br><br>Supplemental study. |
| Acute and Repeat-dose Range-finding Cholinesterase<br><br>Sprague Dawley rats, adults<br><br>PMRA #2057875 | **Acute phase**<br>There were no mortalities or treatment-related effects on clinical signs of toxicity, body weight, body weight gain or on gross pathology noted throughout the study. Time-to-peak data were highly variable (1-8 hours post-dosing). Based on the obtained results, the author selected a time-to-peak effect of 3 hrs.<br><br>**Repeat-dose phase**<br>There were no mortalities or treatment-related effects on clinical signs of toxicity, body weight, body weight gain or on gross pathology noted throughout the study.<br>≥2.5 mg/kg bw: ↓ BChE; ↓ PChE (♂);<br>10 mg/kg bw: ↓ PChE (♀).<br><br>Supplemental study (only 2 animals/time-point examined, highly variable results especially for EChE activity, inconsistent results between genders, dosage levels and the ChE compartments examined and a significant degree of ChE inhibition noted in some groups pre-dosing). |
| Acute Comparative Cholinesterase<br><br>Sprague Dawley rats<br><br>PMRA #2057872 | LOAEL = 0.5 mg/kg bw (Adults, PND11 and PND21 pups)<br><br>**Adults**<br>≥0.5 mg/kg bw: ↓ BChE;<br>≥2.5 mg/kg bw: ↓ PChE (♂);<br>10 mg/kg bw: ↓ PChE (♀).<br><br>**PND11 pups**<br>≥0.5 mg/kg bw: ↓ BChE (♂);<br>≥2.5 mg/kg bw: ↓ PChE (♂); ↓ BChE (♀);<br>10 mg/kg bw: ↓ PChE (♀).<br><br>**PND21 pups**<br>≥0.5 mg/kg bw: ↓ BChE (♀);<br>10 mg/kg bw: ↓ PChE; ↓ BChE (♂).<br><br>*Limited confidence in the EChE data. |

| Study Type/ Animal/PMRA # | Study Results |
|---|---|
| Repeat-dose Comparative Cholinesterase<br><br>Sprague Dawley rats<br><br>PMRA #2057874 | LOAEL = 0.5 mg/kg bw/day (adults). NOAEL = 0.5 mg/kg bw/day (PND11 pups)<br><br>**Adults**<br>≥0.5 mg/kg bw/day: ↓ BChE (♂);<br>≥1.0 mg/kg bw/day: ↓ BChE and PChE (♀);<br>≥2.5 mg/kg bw/day: ↓ PChE (♂).<br><br>**PND11 pups**<br>≥1.0 mg/kg bw/day: ↓ BChE (♂);<br>≥2.5 mg/kg bw/day: ↓ BChE and PChE (♀);<br>10 mg/kg bw/day: ↓ PChE (♂).<br><br>*Limited confidence in the EChE data. |
| Developmental Comparative Cholinesterase<br><br>Sprague Dawley rats<br><br>PMRA #2057873 | LOAEL = 0.5 mg/kg bw/day (Dams and fetuses)<br><br>**Dams**<br>≥0.5 mg/kg bw/day: ↓ BChE;<br>≥2.5 mg/kg bw/day: ↓ PChE.<br><br>**Fetuses**<br>≥0.5 mg/kg bw/day: ↓ BChE (♀);<br>≥1.0 mg/kg bw/day: ↓ BChE (♂);<br>≥2.5 mg/kg bw/day: ↓ PChE.<br><br>*Limited confidence in the EChE data. |
| Developmental Neurotoxicity<br><br>Sprague Dawley rats<br><br>PMRA #2057871 | LOAEL = 0.5 mg/kg bw/day (pups)<br><br>**Dams**<br>No treatment-related effects noted on clinical signs, abbreviated functional observational battery, body weight, body weight gain, food consumption, reproductive performance or gross pathology.<br>*Cholinesterase measurements not performed on maternal animals.<br><br>**Pups**<br>No treatment-related effects noted on offspring survival, body weight, body weight gain, food consumption, clinical signs, functional observational battery, developmental landmarks, auditory startle reflex, passive avoidance phase of learning and memory assessments or brain weights. No treatment-related inhibition was noted in BChE, PChE or EChE activity in male or female pups on PND4.<br>≥0.5 mg/kg bw/day: ↓ BChE (PND21: 25-62%), ↑ number of errors/trial in retention phase of water maze* (memory) (PNDs 65-69) (♂);<br>≥1 mg/kg bw/day: ↓ number of movements and time spent in movement (motor activity) (PND21) (♀);<br>10 mg/kg bw/day: ↓ PChE and EChE (PND21), ↑ thickness of corpus callosum** (PND70 ♂: 10.7% and PND22 ♀: 7.1%).<br>*Dose-response not noted, lack of historical and adequate positive controls add to uncertainty in interpretation.<br>**No effect in PND22 ♂ or PND70 ♀ and no measurements from low- & mid-dose; therefore, biological significance is unclear.<br><br>Acceptable for determination of cholinesterase activity. Supplemental as developmental neurotoxicity study for rats. |

| Study Type/ Animal/PMRA # | Study Results |
|---|---|
| ***In vitro* Studies of Cholinesterase Inhibition** | |
| Rat and Monkey Tissues<br>PMRA #1208008 and 1208121 | Technical acephate (93.6% purity) caused greater inhibition of BChE and EChE than pure acephate (99.3% purity). Methamidophos (a metabolite of acephate) caused greater inhibition than acephate (93.6% or 99.6% purity). |
| Sprague Dawley rat, Cynomolgus monkey and human tissues (2 studies)<br>PMRA #1208004 and 1208099 | The inhibition of BChE, EChE and PChE by acephate was of the same order of magnitude in all three species but differences were noted. Rat BChE and EChE were more sensitive than those of monkey or human. The PChE in humans was most sensitive, monkey slightly less sensitive and rat the least sensitive. |
| **Developmental/Reproductive Toxicity Studies** | |
| Developmental Toxicity<br>ICR (CD-1) mice<br>PMRA #2130586 | Maternal NOAEL = 7 mg/kg bw/day, Developmental NOAEL = 14 mg/kg bw/day<br>**Maternal**<br>≥14 mg/kg bw/day: ↓ maternal brain weights (absolute and relative);<br>28 mg/kg bw/day: cholinergic signs (salivation, vaginal bleeding, tremors and porphyrin deposits around the eyes), ↓ maternal weight gain, ↑ liver weight.<br>**Developmental**<br>28 mg/kg bw/day: ↓ number of live fetuses, ↑ number of early resorptions, ↓ fetal weight, ↑ incidence of external (polydactyly) and skeletal abnormalities (shortening of long bones, incomplete ossification of phalanges and absent phalanges).<br>Note: Cholinesterase activity not measured.<br>Teratogenic at maternally toxic levels. |
| Developmental Toxicity<br>Sprague Dawley rats<br>PMRA #2141830 | Maternal NOAEL = 5 mg/kg bw/day, Developmental NOAEL = 20 mg/kg bw/day<br>**Maternal**<br>≥20 mg/kg bw/day: ↓ weight gain and food consumption;<br>75 mg/kg bw/day: ↑ incidence of tremors, ↓ motor activity.<br>**Developmental**<br>75 mg/kg bw/day: ↓ fetal weight (♀ fetuses).<br>Note: Cholinesterase activity not measured.<br>No evidence of teratogenicity. |
| Developmental Toxicity<br>Dutch Belted rabbits<br>PMRA #1208020 and 1208021 | Maternal and Developmental NOAELs = 3 mg/kg bw/day<br>**Maternal**<br>10 mg/kg bw/day: ↑ incidence of abortion.<br>**Developmental:**<br>10 mg/kg bw/day: ↑ incidence of abortion.<br>Note: Cholinesterase activity not measured.<br>No evidence of teratogenicity. |

| Study Type/ Animal/PMRA # | Study Results |
|---|---|
| 3-generation Dietary Reproductive Toxicity<br>Sprague Dawley rats<br>PMRA #1210937, 1210944, 1210955 and 1210966 | Parental, Offspring and Reproductive NOAELs = 2.5 mg/kg bw/day<br>**Parental**<br>25 mg/kg bw/day: ↓ body weight gain ($F_0$ and $F_1$ ♂, $F_1$ and $F_{2b}$ ♀ during gestation and/or lactation), ↓ food consumption ($F_1$ during lactation) and food utilization; ↑ fluid feces ($F_1$) (♂).<br>**Offspring**<br>25 mg/kg bw/day: ↓ postnatal pup survival to day 4 ($F_{1a}$ and $F_{2a}$).<br>**Reproductive**<br>25 mg/kg bw/day: ↓ litter size ($F_{1a}$, $F_{2a}$ and $F_{2b}$), ↓ mating performance ($F_{2b}$).<br>Note: Cholinesterase activity not measured. |
| Special Reproductive Toxicity<br>ICR (CD-1) mice, ♂ only<br>PMRA #2105184 | NOAEL = 7 mg/kg bw/day, ♂<br>≥14 mg/kg bw/day: ↓ testicular weights, ↓ fertility index, ↓ percent motile sperm and spermatozoa and spermatid counts, ↑ incidence of testicular alterations (tubules with exfoliation of the germinal cells into the lumen with ill-defined spermiogenesis);<br>28 mg/kg bw/day: ↑ incidence of salivation and tremors, ↓ BChE and muscle ChE, ↓ mating index, ↓ number of implantation sites/litter and live fetuses/litter, ↑ number of early resorptions/litter, ↑ incidence of testicular changes (widening of the interstitial spaces, some tubules had thinning of the basement membrane with areas of rupture).<br>Note: At ≥ 7 mg/kg bw/day dose-related degenerative changes in the skeletal muscle were reported but were not quantified. |
| **Genotoxicity Studies** | |
| ***In vitro* Studies** | |
| Gene Mutation<br>Salmonella typhimurium (TA98, TA100, TA1537 and TA1538)<br>PMRA #1208000, 1208014, 1207993, 1154659, 1154660, 1154663 and 1154668 | Weakly positive to TA100. Negative with all other strains (±S9). |
| Gene Mutation<br>Salmonella typhimurium (TA98, TA100, TA1535, TA1537 and TA1538)<br>Escherichia coli (WP2 uvrA)<br>PMRA #1208003, 1154663 and 1249850 | Weakly positive to TA100 at >2,500 µg/plate (±S9). Negative with all other strains (±S9). |

| **Study Type/ Animal/PMRA #** | **Study Results** |
|---|---|
| Mouse Lymphoma Assay<br>Mouse L5718Y TK+/- cells<br>PMRA #1207982, 1207983, 1207984 and 1154661 | Positive in the range of 500 to 5,000 µg/mL. |
| Gene Mutation<br>Escherichia coli p3478 and w3110, Bacillus subtilis w45 and H17<br>PMRA #1208003, 1154663 and 1249850 | Negative. |
| Mitotic Recombination<br>Saccharomyces cerevisiae D3<br>PMRA #1208003, 1154663 and 1249850 | Positive at >2% (w/v or v/v). |
| Unscheduled DNA Synthesis<br>WI38 human fibroblasts<br>PMRA #1208003, 1154663 and 1249850 | Positive at ≥1,000 µg/mL. |
| ***In vivo* Studies** | |
| Cytogenic Assay<br>Mouse bone marrow<br>PMRA #1207994 | Negative. |
| Sister Chromatid Exchange<br>Mouse bone marrow<br>PMRA #1207989 and 1597427 | Negative. |
| Micronucleus Test<br>Mice<br>PMRA #1207986 and 1154664 | Negative. |
| Dominant Lethal Assay<br>Mice<br>PMRA #1142092. | Negative. |

| Study Type/ Animal/PMRA # | Study Results |
|---|---|
| 1207987, 1207988 and 1159238 | |
| Cytogenic Assay<br>Peripheral Lymphocytes Macaca fascicularis<br>PMRA #1207990 | Negative. |
| Mouse Somatic Cell Assay<br>Offspring of pregnant C57B1/B6 female mice<br>PMRA #1210984 and 1210985 | Negative. |

### Table 2 Toxicology Endpoints for Use in Health Risk Assessment for Acephate

| Exposure Scenario | Study | Point of Departure and Endpoint | CAF[1] or Target MOE |
|---|---|---|---|
| Acute dietary | Acute comparative cholinesterase - Rat | LOAEL = 0.5 mg/kg bw<br>Decreased brain cholinesterase activity | 300 |
| | ARfD = 0.0017 mg/kg bw | | |
| Repeated dietary | 13-week dietary toxicity study - Rat | LOAEL = 0.12 mg/kg bw/day<br>Decreased brain cholinesterase activity (close to a threshold NOAEL) | 100 |
| | ADI = 0.0012 mg/kg bw/day | | |
| Short-, intermediate- and long-term dermal | 21-day dermal toxicity study - Rat | NOAEL = 50 mg/kg bw/day<br>Decreased brain cholinesterase activity | 100 |
| Short-, intermediate- and long- term inhalation | 28-day inhalation toxicity study - Rat | NOAEL = 0.001 mg/L (=0.26 mg/kg bw/day)<br>Decreased brain cholinesterase activity | 100 |
| Aggregate short-term and combined[2] short- and long-term | Oral:<br>13-week dietary toxicity study - Rat<br>Dermal:<br>21-day dermal toxicity study - Rat<br>Inhalation:<br>28-day inhalation toxicity study - Rat | LOAEL = 0.12 mg/kg bw/day<br>Decreased brain cholinesterase activity (close to a threshold NOAEL)<br>NOAEL = 50 mg/kg bw/day<br>Decreased brain cholinesterase activity<br>NOAEL = 0.001 mg/L (=0.26 mg/kg bw/day)<br>Decreased brain cholinesterase activity | 100 |
| Cancer | Not required | Not required | Not required |

[1] CAF (composite assessment factor) refers to a total of uncertainty and *Pest Control Products Act* factors for dietary assessments; MOE refers to a target MOE for occupational assessments.

[2] Combined refers to acephate endpoints used in assessments of co-occurrence with methamidophos.

## Table 3 Toxicology Endpoints for Health Risk Assessment for Methamidophos

| Exposure Scenario | Study | Point of Departure and Endpoint | CAF[1] or Target MOE |
|---|---|---|---|
| Acute dietary | Developmental Neurotoxicity Study - Rat | NOAEL = 0.1 mg/kg bw/day<br>Males: impaired memory, Females: decreased auditory startle reflex | 300 |
| | ARfD = 0.0003 mg/kg bw | | |
| Chronic dietary | 2-generation Reproduction Study - Rat | LOAEL = 0.05 mg/kg bw/day<br>Dams: brain cholinesterase inhibition, Offspring: decreased weight gains | 300 |
| | ADI = 0.00017 mg/kg bw/day | | |
| Short- or intermediate-term dermal and inhalation [2, 3] | Developmental Neurotoxicity Study - Rat | NOAEL = 0.1 mg/kg bw/day<br>Males: impaired memory, Females: decreased auditory startle reflex | 300 |
| Long-term dermal and inhalation [2, 3] | 2-generation Reproduction Study - Rat | LOAEL = 0.05 mg/kg bw/day<br>Dams: brain cholinesterase inhibition, Offspring: decreased weight gains | 300 |
| Aggregate short-term [2] | Oral and Dermal: Developmental Neurotoxicity Study - Rat | NOAEL = 0.1 mg/kg bw/day<br>Males: impaired memory, Females: decreased auditory startle reflex | 300 |
| Combined [4] short-term | Oral:<br>13-week Neurotoxicity Study - Rat | LOAEL = 0.07 mg/kg bw/day<br>Brain cholinesterase inhibition | 300 |
| | Dermal:<br>3-week Dermal Study - Rat | BMDL$_{10}$ of 1.81 mg/kg bw/day<br>Brain cholinesterase inhibition | 100 |
| | Inhalation:<br>3-week Inhalation Study - Rat | NOAEL = 0.53 mg/kg bw/day<br>Brain cholinesterase inhibition | 100 |
| Aggregate long-term and Combined long-term | 2-generation Reproduction Study - Rat | LOAEL = 0.05 mg/kg bw/day<br>Dams: brain cholinesterase inhibition, Offspring: decreased weight gains | 300 |
| Cancer | Not required | Not required | Not required |

[1] CAF (composite assessment factor) refers to total of uncertainty and *Pest Control Products Act* factors for dietary assessments. MOE refers to desired margin of exposure for occupational or residential assessments

[2] Since an oral NOAEL was selected, a dermal absorption of 10% is used in a route-to-route extrapolation

[3] Since an oral NOAEL was selected, an inhalation absorption of 100% is used in route-to-route extrapolation.

[4] Combined refers to methamidophos endpoints used in assessments of co-occurrence with acephate.

# Appendix V Occupational Exposure Risk Estimates for Acephate

## Table 1 Dermal and Inhalation MOEs for Mixing, Loading and Applying Acephate using the Soluble Powder Formulation

| Crop | Application Method | Rate (kg a.i. /ha) | Area treated (ha/day) | Dermal MOEs[a] | | | | | | Inhalation MOEs[b] | | | | Combined MOEs[c] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Applying in open cab with the following PPE for M/L/A: | | | | Applying in closed cab with the following PPE: | | w/o resp. | with resp.[m] | ECs[g] w/o resp. | ECs[g] with resp.[m] | Baseline[d] with resp. | Mid-level[e] with resp. | Max.[f] with resp. | Max.[f] with headgear & resp. | EC-1[g] with resp.[m] | EC-2[g] with resp.[m] |
| | | | | Baseline[d] | Mid-level[e] | Maximum[f] | Max.[f] + headgear[j] | EC-1[g] : Baseline[d] | EC-2[g] : Mid-level[e] | | | | | | | | | | |
| **Mixer/Loader/Applicator** | | | | Target MOE = 100 | | | | | | | | | | | | | | | |
| Vegetables[p] | Groundboom | 0.56 | 30 | 369 | 531 | 582 | n/a | 595 | 606 | 19 | 190 | 19 | 191 | 125 | 140 | 143 | n/a | 144 | 145 |
| | | 0.83 | 30 | 249 | 358 | 393 | n/a | 401 | 409 | 13 | 128 | 13 | 129 | 84 | 94 | 96 | n/a | 97 | 98 |
| Corn, sweet & seed | Groundboom | 0.56 | 80 | 138 | 199 | 218 | n/a | 223 | 227 | 7 | 71 | 7 | 71 | 47 | 52 | 54 | n/a | 54 | 54 |
| | | 0.83 | 80 | 93 | 134 | 147 | n/a | 150 | 153 | 5 | 48 | 5 | 48 | 32 | 35 | 36 | n/a | 37 | 37 |
| | | 0.56 | 140[r] | 79 | 114 | 125 | n/a | 128 | 130 | 4 | 41 | 4 | 41 | 27 | 30 | 31 | n/a | 31 | 31 |
| | | 0.83 | 140[r] | 53 | 77 | 84 | n/a | 86 | 88 | 3 | 27 | 3 | 27 | 18 | 20 | 21 | n/a | 21 | 21 |
| Cranberries | Groundboom | 0.56 | 30 | 369 | 531 | 582 | n/a | 595 | 606 | 19 | 190 | 19 | 191 | 125 | 140 | 143 | n/a | 144 | 145 |
| | Airblast[h] | | 16 | 357 | 455 | 481 | 977 | 1026 | 1034 | 33 | 328 | 36 | 328 | 171 | 190 | 195 | 245 | 248 | 249 |
| | Chemigation | | 140 | 84 | 120 | 132 | n/a | n/a | n/a | 4 | 41 | n/a | n/a | 28 | 31 | 31 | n/a | n/a | n/a |
| Potatoes | Groundboom | 0.56 | 65 | 170 | 245 | 29 | n/a | 275 | 280 | 9 | 87 | 9 | 88 | 58 | 64 | 66 | n/a | 67 | 67 |
| | | 0.83 | 65 | 115 | 165 | 181 | n/a | 185 | 189 | 6 | 59 | 6 | 59 | 39 | 44 | 45 | n/a | 45 | 45 |
| | | 0.56 | 300[r] | 37 | 53 | 58 | n/a | 60 | 61 | 2 | 19 | 2 | 19 | 13 | 14 | 14 | n/a | 14 | 15 |
| | | 0.83 | 300[r] | 25 | 36 | 39 | n/a | 40 | 41 | 1 | 13 | 1 | 13 | 8 | 10 | 10 | n/a | 10 | 10 |
| Saskatoon berries | Soil injection[i] | 2.55 | 30 | 81 | 117 | 128 | n/a | 131 | 133 | 4 | 42 | 4 | 42 | 27 | 31 | 31 | n/a | 32 | 32 |
| Tobacco | Groundboom | 0.56 | 30 | 369 | 531 | 582 | n/a | 595 | 606 | 19 | 190 | 19 | 191 | 125 | 140 | 143 | n/a | 144 | 145 |
| | | 0.83 | 30 | 249 | 358 | 393 | n/a | 401 | 409 | 13 | 128 | 13 | 129 | 84 | 94 | 96 | n/a | 97 | 98 |

| Crop | Application Method | Rate (kg a.i. /ha) | Area treated (ha/day) | Dermal MOEs[a] | | | | | | Inhalation MOEs[b] | | | | Combined MOEs[c] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Applying in open cab with the following PPE for M/L/A: | | | | Applying in closed cab with the following PPE: | | w/o resp. | with resp.[m] | ECs[g] w/o resp. | ECs[g] with resp.[n] | Baseline[d] with resp. | Mid-level[e] with resp. | Max.[f] with resp. | Max.[f] with headgear & resp. | EC-1[g] with resp.[m] | EC-2[g] with resp.[m] |
| | | | | Baseline[d] | Mid-level[e] | Maximum[f] | Max.[f] + headgear[j] | EC-1[g] : Baseline[d] | EC-2[g] : Mid-level[e] | | | | | | | | | | |
| **Mixer/Loader/Applicator** | | | | Target MOE = 100 | | | | | | | | | | | | | | | |
| | | 1.13 | 30 | 183 | 263 | 289 | n/a | 295 | 301 | 9 | 94 | 9 | 95 | 62 | 69 | 71 | n/a | 72 | 72 |
| | | 1.28 | 30 | 161 | 232 | 255 | n/a | 260 | 265 | 8 | 83 | 8 | 83 | 55 | 61 | 63 | n/a | 63 | 63 |
| Tomatoes | Groundboom | 0.90 | 30 | 230 | 330 | 362 | n/a | 370 | 377 | 12 | 118 | 12 | 119 | 78 | 87 | 89 | n/a | 90 | 90 |
| Ornamentals outdoors (excluding cut flowers) | Groundboom | 1.31 | 30 | 158 | 227 | 249 | n/a | 254 | 259 | 8 | 81 | 8 | 82 | 54 | 60 | 61 | n/a | 62 | 62 |
| | Airblast[h] | | 16 | 153 | 194 | 206 | 417 | 438 | 442 | 14 | 140 | 15 | 140 | 73 | 81 | 83 | 105 | 106 | 106 |
| | Manually pressurized handwand | 0.64 kg a.i./1000L | 150 L/day | 1855 | 3167 | 3688 | n/a | n/a | n/a | 134 | 1339 | n/a | n/a | 778 | 941 | 982 | n/a | n/a | n/a |
| | Mechanically pressurized handgun[i] | | 3800L/day | 236 | 512 | 667 | n/a | n/a | n/a | 36 | 363 | n/a | n/a | 143 | 212 | 235 | n/a | n/a | n/a |
| | Backpack[i] | | 150 L/day | 6128 | 12341 | 15479 | n/a | n/a | n/a | 1610 | 16101 | n/a | n/a | 4439 | 6986 | 7892 | n/a | n/a | n/a |
| Cut flowers (outdoors) | Groundboom | 0.83 | 30 | 249 | 358 | 393 | n/a | 401 | 409 | 13 | 128 | 13 | 129 | 84 | 94 | 96 | n/a | 97 | 98 |
| | Airblast[h] | | 16 | 241 | 307 | 325 | 659 | 692 | 698 | 22 | 221 | 24 | 221 | 115 | 128 | 132 | 166 | 168 | 168 |
| | Manually pressurized handwand | 0.64 kg a.i./1000L | 150 L/day | 1855 | 3167 | 3688 | n/a | n/a | n/a | 134 | 1389 | n/a | n/a | 778 | 941 | 982 | n/a | n/a | n/a |
| | Mechanically pressurized handgun[i] | | 3800 L/day | 236 | 512 | 667 | n/a | n/a | n/a | 36 | 363 | n/a | n/a | 143 | 212 | 235 | n/a | n/a | n/a |
| | Backpack[i] | | 150 L/day | 6128 | 12341 | 15479 | n/a | n/a | n/a | 1610 | 16101 | n/a | n/a | 4439 | 6986 | 7892 | n/a | n/a | n/a |
| Greenhouse ornamentals. | Hand held mist blower | No data to assess this scenario; exposure is expected to be significant due to inhalation of mist. | | | | | | | | | | | | | | | | | |

| Crop | Application Method | Rate (kg a.i. /ha) | Area treated (ha/day) | Dermal MOEs[a] | | | | | | Inhalation MOEs[b] | | | | Combined MOEs[c] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Applying in open cab with the following PPE for M/L/A: | | | | Applying in closed cab with the following PPE: | | w/o resp. | with resp.[m] | ECs[g] w/o resp. | ECs[g] with resp.[m] | Baseline[d] with resp. | Mid-level[e] with resp. | Max.[f] with resp. | Max.[f] with headgear & resp. | EC-1[g] with resp.[m] | EC-2[g] with resp.[m] |
| | | | | Baseline[d] | Mid-level[e] | Maximum[f] | Max.[f] + headgear[i] | EC-1[g] : Baseline[d] | EC-2[g] : Mid-level[e] | | | | | | | | | | |
| **Mixer/Loader/Applicator** | | | | Target MOE = 100 | | | | | | | | | | | | | | | |
| cut flowers and roses | Automated spray equipment[k] | 0.83 | 1 ha | 7936 | 11362 | 12435 | n/a | n/a | n/a | 390 | 3902 | n/a | n/a | 2616 | 2904 | 2970 | n/a | n/a | n/a |
| | Manually pressurized handwand | 0.64 kg a.i./1000L | 150 L/day | 1855 | 3167 | 3688 | n/a | n/a | n/a | 134 | 1339 | n/a | n/a | 778 | 941 | 982 | n/a | n/a | n/a |
| | Mechanically pressurized handgun[j] | | 3800 L/day | 236 | 512 | 667 | n/a | n/a | n/a | 36 | 363 | n/a | n/a | 143 | 212 | 235 | n/a | n/a | n/a |
| | Backpack[j] | | 150 L/day | 6128 | 12341 | 15479 | n/a | n/a | n/a | 1610 | 16101 | n/a | n/a | 4439 | 6986 | 7892 | n/a | n/a | n/a |
| Trees | Airblast[h] | 1.31 | 16 | 153 | 194 | 206 | 417 | 438 | 442 | 14 | 140 | 15 | 140 | 73 | 81 | 83 | 105 | 106 | 106 |
| | Manually pressurized handwand | 0.64 kg a.i./1000L | 150 L/day | 1855 | 3167 | 3688 | n/a | n/a | n/a | 134 | 1339 | n/a | n/a | 778 | 941 | 982 | n/a | n/a | n/a |
| | Mechanically pressurized handgun[j] | | 3800 L/day | 236 | 512 | 667 | n/a | n/a | n/a | 36 | 363 | n/a | n/a | 143 | 212 | 235 | n/a | n/a | n/a |
| | Backpack[j] | | 150 L/day | 6128 | 12341 | 15479 | n/a | n/a | n/a | 1610 | 16101 | n/a | n/a | 4439 | 6986 | 7892 | n/a | n/a | n/a |
| | Tree trunk injection (pipette or syringe)[q] | 0.02 kg a.i./tree[o] | 200 trees | 2137 | 3060 | 3349 | n/a | n/a | n/a | 105 | 1051 | n/a | n/a | 100 | 101 | 102 | n/a | n/a | n/a |

[a] Dermal MOE = (dermal NOAEL) / (dermal exposure). The dermal NOAEL is 50 mg/kg body weight/day. The target dermal MOE is 100.

[b] Inhalation MOE = (inhalation NOAEL / inhalation exposure. The inhalation NOAEL is 0.26 mg/kg body weight/day. The target inhalation MOE is 100.

[c] Combined MOE = 1/[1/dermal MOE + 1/inhalation MOE]. The target combined MOE is 100.

[d] Baseline PPE = long sleeves, long pants and gloves (no gloves in closed or open cab).

[e] Midlevel PPE = coveralls over single layer, gloves (no gloves in closed cab).

[f] Maximum PPE = chemical-resistant coveralls over single layer and gloves.

[g] EC = engineering controls

[h] EC values for airblast applicators include gloves because data for closed cab without gloves are not available in PHED.

[i] PHED does not contain application data for applying by soil injection. The PMRA believes exposure during application would be similar to application with groundboom. Therefore, the unit exposure numbers of groundboom application were used as surrogate data to assess this scenario.

[j] PHED does not contain data for mechanically pressurized handwand and backpack using a soluble powder. Exposure estimates are based on PHED liquid formulation for each use plus PHED mix/load soluble powder data. Engineering controls do not apply.

[k] PHED does not contain data for greenhouse automated spray equipment. Exposure estimates are based on PHED open mix/load soluble powder data.

[l] Headgear is assumed to be worn only during airblast application.

[m] A respirator is assumed to be worn by workers during mixing, loading and applying in an open cab.

[n] For ECs in a closed cab, a respirator is assumed to be worn by workers only during mixing and loading.

[o] Rate calculated based on 24 injections per tree and 0.642 g a.i./injection

[p] Vegetables includes: Brussels sprouts, cabbage, cauliflower, head lettuce, celery and sweet red pepper

[q] PHED does not contain data for tree trunk injection using a pipette or syringe. Exposure estimates are based on PHED open mix/load soluble powder formulation data. PMRA has low confidence in this assessment.

[r] Custom applicator

n/a = not applicable

w/o = without

resp = respirator

Shaded cells are below the target MOE of 100.

## Table 2 Dermal and Inhalation MOEs for Mixing, Loading and Applying Acephate using the Pelletized Formulation[a]

| Crop | Application Method | Rate (kg a.i./ha) | Area Treated per day (ha/day) | Dermal MOE[b] | Inhalation MOEs[c] | | Combined MOEs[d] | |
|---|---|---|---|---|---|---|---|---|
| | | | | Baseline PPE[e] | Without respirator | With respirator | Without respirator | With respirator |
| Vegetables [f] | Groundboom | 0.56 | 30 | 3013 | 988 | 9884 | 744 | 2309 |
| | | 0.83 | | 2033 | 667 | 6669 | 502 | 1558 |
| Corn, sweet & seed | Groundboom | 0.56 | 80 | 1130 | 371 | 3707 | 279 | 866 |
| | | 0.83 | | 762 | 250 | 2501 | 188 | 584 |
| | | 0.56 | 140[k] | 646 | 212 | 2118 | 159 | 495 |
| | | 0.83 | | 436 | 143 | 1429 | 108 | 334 |
| Cranberries | Groundboom | 0.56 | 30 | 3013 | 988 | 9884 | 744 | 2309 |
| | Airblast | | 16 | 653 | 342 | 3422 | 225 | 549 |
| | chemigation | | 140 | 1235 | 17069 | 1707 | 716 | 1151 |
| Potatoes | Groundboom | 0.56 | 65 | 1391 | 456 | 4562 | 344 | 1066 |
| | | 0.83 | | 938 | 308 | 3078 | 232 | 719 |

| Crop | Application Method | Rate (kg a.i./ha) | Area Treated per day (ha/day) | Dermal MOE[b] | Inhalation MOEs[c] | | Combined MOEs[d] | |
|---|---|---|---|---|---|---|---|---|
| | | | | Baseline PPE[e] | Without respirator | With respirator | Without respirator | With respirator |
| | | 0.56 | 300[k] | 301 | 99 | 988 | 74 | 231 |
| | | 0.83 | | 203 | 67 | 667 | 50 | 156 |
| Saskatoon berries | Soil injection[g] | 2.55 | 30 | 662 | 217 | 2171 | 163 | 507 |
| Tobacco | Groundboom | 0.422 | 30 | 3999 | 1312 | 13117 | 988 | 3064 |
| | | 0.619 | | 2726 | 894 | 8942 | 673 | 2089 |
| | | 0.844 | | 1999 | 656 | 6558 | 494 | 1532 |
| | | 0.956 | | 1756 | 579 | 5790 | 436 | 1353 |
| Tomatoes | Groundboom | 0.90 | 30 | 1875 | 645 | 6150 | 463 | 1437 |
| Ornamentals outdoors (excluding cut flowers) | Groundboom | 1.31 | 30 | 1288 | 423 | 4225 | 318 | 987 |
| | Airblast | | 16 | 279 | 146 | 1463 | 96 | 235 |
| | Manually pressurized handwand | 0.64 kg a.i./1000L | 150 L/day | 38829 | 4214 | 42141 | 3801 | 20209 |
| | Mechanically pressurized handgun[h] | | 3800 L/day | 259 | 50 | 498 | 42 | 170 |
| | Backpack[h] | | 150 L/day | 6726 | 3067 | 30672 | 2107 | 5516 |
| Cut flowers (outdoors) | Groundboom | 0.83 | 30 | 2033 | 667 | 6669 | 502 | 1558 |
| | Airblast | | 16 | 441 | 231 | 2309 | 152 | 370 |
| | Manually pressurized handwand | 0.64 kg a.i./1000L | 150 L/day | 38829 | 4214 | 42141 | 3801 | 20209 |
| | Mechanically pressurized handgun[h] | | 3800 L/day | 259 | 50 | 498 | 42 | 170 |
| | Backpack[h] | | 150 L/day | 6726 | 3067 | 30672 | 2107 | 5516 |
| Greenhouse ornamentals, cut flowers and roses | Hand held mistblower | No data to assess this scenario; exposure is expected to be significant due to inhalation of mist. | | | | | | |
| | Automated spray equipment[i] | 0.83 | 1 ha | 116617 | 1612332 | 161233 | 67671 | 108751 |
| | Manually pressurized | 0.64 kg | 150L/day | 38829 | 4214 | 42141 | 3801 | 20209 |

| Crop | Application Method | Rate (kg a.i./ha) | Area Treated per day (ha/day) | Dermal MOE[b] | Inhalation MOEs[c] | | Combined MOEs[d] | |
|---|---|---|---|---|---|---|---|---|
| | | | | Baseline PPE[e] | Without respirator | With respirator | Without respirator | With respirator |
| | handwand | a.i./1000L | | | | | | |
| | Mechanically pressurized handgun[h] | | 3800 L/day | 259 | 50 | 498 | 42 | 170 |
| | Backpack[h] | | 150 L/day | 6726 | 3067 | 30672 | 2107 | 5516 |
| Trees | Airblast | 1.31 | 16 | 279 | 146 | 1463 | 96 | 235 |
| | Manually pressurized handwand | 0.64 kg a.i./1000L | 150 L/day | 38829 | 4214 | 42141 | 3801 | 20209 |
| | Mechanically pressurized handgun[g] | | 3800 L/day | 259 | 50 | 498 | 42 | 170 |
| | Backpack[g] | | 150 L/day | 6726 | 3067 | 30672 | 2107 | 5516 |
| | Tree trunk injection (pipette or syringe) | 0.02 kg a.i. / tree[j] | 200 trees | 31410 | 42186 | 421859 | 18004 | 29233 |

[a] Mix/load exposure when using a pelletized formulation of acephate was estimated using a submitted study. For dermal exposure, the arithmetic mean including all three sites was used (36.16 ug/kg a.i. handled). For inhalation exposure the arithmetic mean including all three sites was used (0.136 ug/kg a.i. handled).

[b] Dermal MOE = (dermal NOAEL) / (dermal exposure). The dermal NOAEL is 50 mg/kg body weight/day. The target dermal MOE is 100. Dermal exposure ug/kg bw/day = (unit exposure × area treated × rate) / 70 kg bw.

[c] Inhalation MOE = ( inhalation NOAEL / inhalation exposure). The inhalation NOAEL is 0.26 mg/kg body weight/day. The target inhalation MOE is 100.

[d] Combined MOE = 1/[1/dermal MOE + 1/inhalation MOE]. Target MOE is 100.

[e] Baseline PPE = long sleeves, long pants and gloves.

[f] Vegetables: Brussels sprouts, cabbage, cauliflower, head lettuce, celery and sweet bell pepper

[g] PHED does not contain application data for applying by soil injection. The PMRA believes exposure during application would be similar to application with groundboom. Therefore, the unit exposure numbers of groundboom application were used as surrogate data to assess this scenario.

[h] PHED does not contain data for mechanically pressurized handwand and backpack using a pellet formulation. Exposure estimates are based on PHED liquid formulation for each use.

[i] PHED does not contain data for greenhouse automated spray equipment. Exposure estimates are based on PHED open mix/load soluble powder data.

[j] Rate calculated based on 24 injections per tree and 0.642 g a.i./injection.

[k] Custom applicator

n/a = not applicable

Shaded cells are below the target MOE of 100.

## Table 3 Postapplication Short-term and Long-term Exposure Estimates, MOEs, ARIs and REIs for Maximum Label Rate and Maximum Number of Applications[a]

| Crop | App. Rate (kg a.i./ha)[b] | Number of Apps.[c] | Activity[d] | TC[e] ($cm^2$/hr) | PHI[f] (days) | Acephate | | Methamidophos | | Combined Risk | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | MOE on Day 0[g] | Proposed REI[h] (days) | MOE on Day 0[i] | Proposed REI[h] (days) | ARI on proposed REI[j] | Proposed REI[h] (days) |
| Brussels sprouts, cauliflower | 0.83 | 2 | Hand harvesting | 5150 | 28 | 230 | 0.5 | 253 | 3 | 2.1 | 3 |
| | | | All other activities | 230 - 4400 | | ≥ 269 | 0.5 | ≥ 296 | 0.5 | ≥1.8 | 0.5 |
| Cabbage | 0.83 | 2 | All activities | 1300 - 4400 | 28 | ≥ 269 | 0.5 | ≥ 296 | 0.5 | ≥1.8 | 0.5 |
| Celery, lettuce, peppers | 0.83 | 4 | Hand set irrigation | 1750 | 7 - 21 | 368 | 0.5 | 149 | 7 | 4.1 | 7 |
| | | | Hand harvesting, tying/training (peppers) | 1100 | | 585 | 0.5 | 237 | 3 | 3.8 | 3 |
| | | | All other activities | 70 - 230 | | ≥2798 | 0.5 | ≥1134 | 0 | ≥11.8 | 0.5 |
| Tobacco – mature plants | 0.83 (SP) | 3 | Hand set irrigation | 1750 | n/a | 829 | 0.5 | 160 | 8 | 4.7 | 8 |
| | | | All other activities | 90 - 800 | | ≥ 1813 | 0.5 | ≥ 349 | 0.5 | ≥ 4.7 | 0.5 |
| | 0.619 (pellet) | 3 | Hand set irrigation | 1750 | | 1105 | 0.5 | 213 | 4 | 4.2 | 4 |
| | | | All other activities | 90 - 800 | | ≥ 2416 | 0.5 | ≥ 466 | 0.5 | ≥ 6.2 | 0.5 |
| Tobacco – at transplant (seedling) | 1.275 (SP) | 1 | All activities | 90 -230 | n/a | ≥ 4080 | 0.5 | ≥ 786 | 0.5 | ≥ 10.6 | 0.5 |
| | 0.956 (pellet) | 1 | All activities | 90 - 230 | | ≥ 5441 | 0.5 | ≥ 1049 | 0.5 | ≥ 14.1 | 0.5 |
| Cranberries | 0.562 | 2 | Hand harvesting, raking, scouting | 1100 | not stated | 191 | 0.5 | 160 | 6 | 1.4 | 6 |
| | | | All other activities | 70 - 230 | | ≥ 916 | 0.5 | ≥763 | 0.5 | ≥ 5.5 | 0.5 |
| Corn (seed) | 0.83 | 4 | Hand de-tasseling | 16000 | n/a | 40 | 5 | 16 | 27 | 5.2 | 27 |
| | | | Hand set irrigation | 1750 | | 368 | 0.5 | 149 | 7 | 4.1 | 7 |
| | | | Scouting (late season) | 1100 | | 585 | 0.5 | 237 | 3 | 3.8 | 4 |
| | | | All other activities | 70 - 210 | | ≥3065 | 0.5 | ≥1242 | 0.5 | ≥13.0 | 0.5 |
| Corn (sweet) | 0.83 | 4 | Hand harvesting | 16000 | 21 | 40 | 5 | 16 | 27 | 5.2 | 27 |
| | | | Hand set irrigation | 1750 | | 368 | 0.5 | 149 | 7 | 4.1 | 7 |
| | | | All other activities | 70 - 210 | | ≥3065 | 0.5 | ≥1242 | 0.5 | ≥13.0 | 0.5 |
| Tomatoes (seedling) | 0.9 | 1 | All activities | 70 - 1100 | Not stated | ≥673 | 0.5 | ≥319 | 0.5 | ≥3.1 | 0.5 |
| Potatoes | 0.83 | 4 | Hand set irrigation | 1750 | 21 | 368 | 0.5 | 149 | 7 | 4.1 | 7 |
| | | | Roughing | 1000 | | 644 | 0.5 | 260 | 2 | 3.6 | 2 |
| | | | All other activities | 70 - 210 | | ≥3065 | 0.5 | ≥1242 | 0.5 | ≥13.0 | 0.5 |
| Outdoor Ornamentals | 1.31 | 2 | Hand set irrigation | 1750 | n/a | 52 | 7 | 43 | 19 | 2.3 | 19 |
| | | | All other activities | 230 | | 393 | 0.5 | 327 | 0.5 | 2.4 | 0.5 |
| Outdoor roses and | 0.83 | 2 | Hand harvesting, disbudding, | 4000 | n/a | 201 | 0.5 | 95 | 11 | 4.3 | 11 |

| Crop | App. Rate (kg a.i./ha)[b] | Number of Apps.[c] | Activity[d] | TC[e] (cm²/hr) | PHI[f] (days) | Acephate | | Methamidophos | | Combined Risk | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | MOE on Day 0[g] | Proposed REI[h] (days) | MOE on Day 0[i] | Proposed REI[h] (days) | ARI on proposed REI[j] | Proposed REI[h] (days) |
| cut flowers | | | hand pruning | | | | | | | | |
| | | | Hand set irrigation | 1750 | | 458 | 0.5 | 217 | 3 | 3.3 | 3 |
| | | | All other activities | 230 | | 3488 | 0.5 | 1653 | 0.5 | 16.1 | 0.5 |
| Trees (coniferous, deciduous) | 1.31 | 2 | Hand set irrigation | 1750 | n/a | 76 | 3 | 64 | 15 | 2.2 | 15 |
| | | | Harvesting (Christmas trees) | 1400 | | 95 | 0.5 | 79 | 13 | 2.3 | 13 |
| | | | Scouting, shaping, hand pruning | 580 | | 230 | 0.5 | 192 | 5 | 2.3 | 5 |
| | | | Transplanting, hand weeding, grading/tagging | 100-230 | | 580-1334 | 0.5 | 483-1112 | 0.5 | 3.5-8.0 | 0.5 |
| Greenhouse ornamentals + nursery plants (short term)[k] | 0.83 | 2 | Hand set irrigation | 1750 | n/a | 1497 | 0.5 | 129 | 2 | 5.4 | 2 |
| | | | All other activities | 230 | | 11387 | 0.5 | 982 | 0.5 | 15.4 | 0.5 |
| Greenhouse cut flowers (short term)[k] | 0.83 | 2 | Hand harvesting, disbudding, hand pruning | 4000 | n/a | 265 | 1 | 56 | 2 | 2.4 | 2 |
| | | | Hand set irrigation | 1750 | | 607 | 0.5 | 129 | 2 | 5.4 | 2 |
| | | | All other activities | 230 | | 4617 | 0.5 | 982 | 0.5 | 12.8 | 0.5 |
| Greenhouse ornamentals + nursery plants **(long term)**[k] | 0.83 | 2 | Hand set irrigation | 1750 | n/a | 3804 | 0.5 | 271 | 1 | 1.4 | 1 |
| | | | All other activities | 230 | | 28943 | 0.5 | 2065 | 0.5 | 6.6 | 0.5 |
| Greenhouse cut flowers **(long term)**[k] | 0.83 | 2 | Hand harvesting, disbudding, hand pruning | 4000 | n/a | 1664 | 0.5 | 119 | 2 | 1.5 | 2 |
| | | | Hand set irrigation | 1750 | | 3804 | 0.5 | 271 | 1 | 1.4 | 1 |
| | | | All other activities | 230 | | 28943 | 0.5 | 2065 | 0.5 | 6.7 | 0.5 |

[a] Postapplication exposure was assumed to be the same regardless of the formulation of the pesticide applied.

[b] Maximum application rate as per current labels. SP soluble powder; Pellet: pelletized formulation.

[c] Maximum number of applications permitted on the label, or where a maximum is not stated, a maximum was assumed based on registrant consultation.

[d] Activities are grouped as per common transfer coefficient or in some cases, "all other activities" is indicated where risk is acceptable at the minimum REI of 0.5 days.

[e] Transfer coefficients (TC) are from the ARTF Transfer Coefficients (TC): Evaluation and PMRA Agricultural TC Table (PMRA#2115788).

[f] PHI = Preharvest Interval as stated on label.

[g] Acephate Dermal MOE = (dermal NOAEL) / (dermal exposure). The acephate dermal NOAEL is 50 mg/kg body weight/day. The target MOE is 100. The dermal exposure was calculated using DFR studies. See Section 3.2. Dermal Exposure = DFR × TC × 8hr / 70kg.

[h] REI = Restricted-entry interval. Day at which the dermal exposure results in an ARI≥1. Where target ARI was met at Day 0, a minimum REI of 0.5 days (12 hrs) was specified.

[i] Methamidophos Dermal MOE = (dermal NOAEL) / (dermal exposure). The methamidophos dermal NOAEL (from oral study) is 0.1 mg/kg bw/day. The target MOE is 300. The dermal exposure was calculated using DFR studies. See Section 3.2. Dermal Exposure = [DFR × TC × 8hr / 70kg] × DA

[j] Dermal exposure from acephate and methamidophos co-occurs; therefore, a combined risk assessment was conducting using appropriate NOAELs and a calculated ARI (Aggregate Risk Index).

ARI = 1/[(ACP target MOE/ACP MOE) + (MOM target MOE/MOM MOE)] . The acephate combined dermal NOAEL is 50 mg/kg body weight/day. The target MOE is 100. The methamidophos combined dermal **BMDL**$_{10}$ is 1.81 mg/kg bw/day. The target MOE is 100.

[k] Greenhouse ornamentals were assessed for short term and long term exposure, to ensure that all possible exposure scenarios are covered. For long term exposure the DFR data was adjusted to a time weighted average of the residues on Day 0 (or REI day) until day 30, as data permitted. Also, long term toxicology endpoints were used. The acephate long-term dermal NOAEL is the same as the short-term NOAEL at 50 mg/kg bw/day with a target MOE of 100. The methamidophos long term dermal NOAEL (from an oral study) is 0.05 mg/kg bw/day with a target MOE of 300. The combined long-term risk assessment used the same toxicology endpoints as the individual long-term risk assessment.

n/a not applicable

Shaded cells are either below the target MOE of 100 for ACP and 300 for MOM or they are proposed REIs that may not be agronomically feasible.

### Table 4 Postapplication Exposure Estimates, MOEs, ARIs and REIs when Mitigation Measures Proposed for the Dietary Assessment are Applied (For Example Rates are Lowered and the Number of Applications is Reduced)[a]

| Crop | App. Rate (kg a.i./ha)[b] | Activity[d] | Number of Applications[c] | TC[e] (cm$^2$/hr) | PHI[f] (days) | Acephate | | Methamidophos | | Combined Risk | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | MOE on Day 0[g] | Proposed REI[h] (days) | MOE on Day 0[i] | Proposed REI[h] (days) | ARI on proposed REI[j] | Proposed REI (days) |
| Brussels sprouts, cauliflower | 0.56 | All Activities | 2 | 230 - 5150 | 28 | ≥337 | 0.5 | ≥370 | 0.5 | ≥2.2 | 0.5 |
| Cabbage | 0.56 | All activities | | 1300 - 4400 | 28 | ≥394 | 0.5 | ≥433 | 0.5 | ≥2.6 | 0.5 |
| Celery, lettuce, sweet bell peppers | 0.56 | All Activities | | 70-1750 | 7 - 21 | ≥676 | 0.5 | ≥320 | 0.5 | ≥3.4 | 0.5 |
| Corn (seed) | 0.56 | Hand Detasseling | | 16000 | n/a | 74 | 2 | 35 | 20 | 4.6 | 20 |
| | | All other activities | | 70-1750 | | ≥676 | 0.5 | ≥320 | 0.5 | ≥3.1 | 0.5 |
| Corn (sweet) | 0.56 | Hand harvesting | | 16000 | 21 | 74 | 2 | 35 | 20 | 4.6 | 20 |
| | | All other activities | | 70-1750 | | ≥676 | 0.5 | ≥320 | 0.5 | ≥3.1 | 0.5 |

[a] Postapplication exposure was assumed to be the same regardless of the formulation of the pesticide applied.

[b] Application rates are the reductions proposed to reduce exposure due to food and drinking water as in Section 3.4.1.

[c] Number of Applications proposed to reduce exposure due to food and drinking water as in Section 3.4.1.

[d] Activities are grouped as per common transfer coefficient or in some cases, "all other activities" is indicated where risk is acceptable at the minimum REI of 0.5 days.

[e] Transfer coefficients (TC) are from the ARTF Transfer Coefficients (TC): Evaluation and PMRA Agricultural TC Table (PMRA#2115788).

[f] PHI = Preharvest Interval as stated on label.

[g] Acephate Dermal MOE = (dermal NOAEL / (dermal exposure). The acephate dermal NOAEL is 50 mg/kg body weight/day. The target MOE is 100. The dermal exposure was calculated using the DFR studies. See Section 3.2. Dermal Exposure = DFR × TC × 8hr / 70kg

[h] REI = Restricted-entry interval. Day at which the dermal exposure results in an ARI≥1. Where target ARI was met at Day 0, a minimum REI of 0.5 days (12 hrs) was specified.

[i] Methamidophos Dermal MOE = (dermal NOAEL) / (dermal exposure). The methamidophos dermal NOAEL (from an oral study) is 0.1 mg/kg bw/day. The target MOE is 300. The dermal exposure was calculated using DFR studies. See Section 3.2.

[j] Dermal exposure from acephate and methamidophos co-occurs; therefore, a combined risk assessment was conducting using appropriate NOAELs and a calculated ARI (Aggregate Risk Index). ARI = 1/[(ACP target MOE/ACP MOE) + (MOM target MOE/MOM MOE)] . The acephate combined dermal NOAEL is 50 mg/kg body weight/day. The target MOE is 100. The methamidophos combined dermal **BMDL**$_{10}$ is 1.81 mg/kg bw/day. The target MOE is 100.

n/a not applicable

Shaded cells are below the target MOE of 100 for ACP and 300 for MOM.

# Appendix VI Residential (Non-Occupational) Short-term Exposure and Risk Assessment

## Table 1 Post Application short-, intermediate-term dermal exposure estimates, MOEs, and ARIs for Residential Gardening

| Activity | Population Subgroup[a] | TC ($cm^2$/hr)[b] | Formulation[c] | Rate (kg a.i./ha)[d] | ACP MOE[e] | MOM MOE[f] | Combined Risk[g] | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | ACP MOE | MOM MOE | ARI |
| **Number of Applications = 1** | | | | | | | | | |
| Residential Gardening[h] | Adults | 8400 | SP or Pellet | 0.83 | 81 | 572 | 81 | 1035 | 0.7 |
| | Youth (11>16) | 6900 | | | 70 | 496 | 70 | 898 | 0.6 |
| | Children (6>11) | 4600 | | | 119 | 836 | 119 | 1512 | 1.1 |
| **Number of Applications = 2** | | | | | | | | | |
| Residential Gardening[h] | Adults | 8400 | SP or Pellet | 0.83 | 397 | 188 | 397 | 340 | 1.83 |
| | Youth (11>16) | 6900 | | | 344 | 163 | 344 | 295 | 1.59 |
| | Children (6>11) | 4600 | | | 580 | 275 | 580 | 497 | 2.68 |

ACP = Acephate

MOM = Methamidophos

[a] Population subgroups are described in the Revised EPA 2012 Standard Operating Procedures (SOPs) for Residential Exposure Assessments.

[b] Transfer co-efficient for residential gardening is a composite TC and is based on 4 studies (weeding, tying, harvesting, pinching). The TC was scaled for body surface area and typical clothing work in residential areas.

[c] SP soluble powder; Pellet: pelletized formulation

[d] Rate is the maximum rate on current labels.

[e] Acephate Dermal MOE = (dermal NOAEL / (dermal exposure). The acephate dermal NOAEL is 50 mg/kg body weight/day. The target MOE is 100. The dermal exposure was calculated using the bean DFR study. See Section 3.2.

[f] Methamidophos Dermal MOE = (dermal NOAEL) / (dermal exposure). The methamidophos dermal NOAEL (from an oral study) is 0.1 mg/kg bw/day. The target MOE is 300. The dermal exposure was calculated using the bean DFR study. See Section 3.2.

[g] Dermal exposure from acephate and methamidophos co-occurs; therefore, a combined risk assessment was conducting using appropriate NOAELs and a calculated ARI (Aggregate Risk Index). ARI = 1/[(ACP target/ACP MOE) + (MOM target/MOM MOE)] . The acephate combined dermal NOAEL is 50 mg/kg body weight/day. The target MOE is 100. The methamidophos combined dermal $BMDL_{10}$ is 1.81 mg/kg bw/day. The target MOE is 100. The target ARI is 1.

[h] The daily duration of exposure for residential exposure is assumed to be 2.2 hours for adults and youth and 1.1 hrs for children.

Shaded cells are below the target MOE of 100 for ACP and 300 for MOM or below the target ARI of 1.0.

## Appendix VII Dietary Exposure and Risk Estimates for Acephate and Methamidophos

### Table 1 Acute Acephate and Methamidophos Exposure and Risk Estimates for Food Alone

| **Population Groups** | **ACP Exposure- Food** | | **MOM Exposure-Food** | |
|---|---|---|---|---|
| | **mg/kg bw/day** | **% ARfD[1]** | **mg/kg bw/day** | **% ARfD[2]** |
| General Population | 0.00051 | 30 | 0.00016 | 51 |
| All Infants (<1 years) | 0.00019 | 11 | 0.00005 | 17 |
| Children 1-2 years | 0.00059 | 35 | 0.00016 | 52 |
| Children 3-5 years | 0.00053 | 31 | 0.00015 | 50 |
| Children 6-12 years | 0.00047 | 28 | 0.00013 | 43 |
| Youth 13-19 years | 0.00035 | 20 | 0.00010 | 34 |
| Adult 20-49 years | 0.00056 | 33 | 0.00017 | 56 |
| Adult 50+ years | 0.00050 | 29 | 0.00016 | 54 |
| Females 13-49 years | 0.00047 | 28 | 0.00015 | 49 |

Exposure reported at the 99.9th percentile. ACP = acephate. MOM = methamidophos. ARfD = acute reference dose

[1] Acute reference dose for acephate = 0.0017 mg/kg bw

[2] Acute reference dose for methamidophos = 0.0003 mg/kg bw

### Table 2 Acute Acephate and Methamidophos Exposure and Risk Estimates for Food and Drinking Water (no mitigation)

| **Population Groups** | **ACP Exposure-Food and Water** | | **MOM Exposure-Food and Water** | |
|---|---|---|---|---|
| | **mg/kg bw/day** | **% ARfD[1]** | **mg/kg bw/day** | **% ARfD[2]** |
| General Population | 0.019 | 1121 | 0.006 | 2092 |
| All Infants (<1 years) | 0.049 | 2876 | 0.016 | 5404 |
| Children 1-2 years | 0.019 | 1131 | 0.006 | 2113 |
| Children 3-5 years | 0.019 | 1094 | 0.006 | 2050 |
| Children 6-12 years | 0.011 | 676 | 0.004 | 1269 |
| Youth 13-19 years | 0.012 | 735 | 0.004 | 1375 |
| Adult 20-49 years | 0.014 | 836 | 0.005 | 1557 |
| Adult 50+ years | 0.010 | 580 | 0.003 | 1086 |
| Females 13-49 years | 0.013 | 792 | 0.004 | 1485 |

Exposure reported at the 99.9th percentile. ACP = acephate. MOM = methamidophos. ARfD = acute reference dose

[1] Acute reference dose for acephate = 0.0017 mg/kg bw

[2] Acute reference dose for methamidophos = 0.0003 mg/kg bw

## Table 3 Acute Acephate and Methamidophos Exposure and Risk Estimates for Food and Drinking Water (refined and mitigation applied)

| Population Groups | ACP Exposure-Food and Water Refined[1] | | MOM Exposure-Food and Water Refined[1] | |
|---|---|---|---|---|
| | mg/kg bw/day | % ARfD[2] | mg/kg bw/day | % ARfD[3] |
| General Population | 0.00056 | 33 | 0.00016 | 52 |
| All Infants (<1 years) | 0.00084 | 49 | 0.00010 | 34 |
| Children 1-2 years | 0.00069 | 41 | 0.00016 | 53 |
| Children 3-5 years | 0.00060 | 35 | 0.00015 | 49 |
| Children 6-12 years | 0.00051 | 30 | 0.00013 | 42 |
| Youth 13-19 years | 0.00039 | 23 | 0.00010 | 33 |
| Adult 20-49 years | 0.00060 | 35 | 0.00017 | 56 |
| Adult 50+ years | 0.00053 | 31 | 0.00016 | 54 |
| Females 13-49 years | 0.00052 | 31 | 0.00015 | 49 |

Exposure reported at the 99.9th percentile. ACP = acephate. MOM = methamidophos. ARfD = acute reference dose

[1] Refined water estimates include consideration of mitigation measures and refinements to the modelled drinking water residues.

[2] Acute reference dose for acephate = 0.0017 mg/kg bw

[3] Acute reference dose for methamidophos = 0.0003 mg/kg bw

## Table 4 Chronic Acephate and Methamidophos Exposure and Risk Estimates for Food Alone

| Population Groups | ACP Exposure- Food | | MOM Exposure-Food | | ARI |
|---|---|---|---|---|---|
| | mg/kg bw/day | % ADI[1] | mg/kg bw/day | % ADI[2] | |
| General Population | 0.000006 | <1 | 0.000002 | 1 | 60 |
| All Infants (<1 years) | 0.000001 | <1 | <0.0000001 | <1 | 1200 |
| Children 1-2 years | 0.000007 | <1 | 0.000002 | 1 | 57 |
| Children 3-5 years | 0.000007 | <1 | 0.000002 | 1 | 57 |
| Children 6-12 years | 0.000005 | <1 | 0.000002 | 1 | 63 |
| Youth 13-19 years | 0.000004 | <1 | 0.000001 | <1 | 109 |
| Adult 20-49 years | 0.000007 | <1 | 0.000002 | 1 | 57 |
| Adult 50+ years | 0.000006 | <1 | 0.000002 | 1 | 60 |
| Females 13-49 years | 0.000006 | <1 | 0.000002 | 1 | 60 |

ACP = acephate. MOM = methamidophos. ADI = acceptable daily intake. ARI = aggregate risk index

[1] Acceptable daily intake for acephate = 0.0012 mg/kg bw/day

[2] Acceptable daily intake for methamidophos = 0.00017 mg/kg bw/day

### Table 5 Chronic Acephate and Methamidophos Exposure and Risk Estimates for Food and Drinking Water

| Population Groups | ACP Exposure- Food and Water | | MOM Exposure-Food and Water | | ARI |
|---|---|---|---|---|---|
| | mg/kg bw/day | % ADI[1] | mg/kg bw/day | % ADI[2] | |
| General Population | 0.00014 | 12 | 0.00004 | 22 | 2.9 |
| All Infants (<1 years) | 0.00044 | 36 | 0.00012 | 69 | 0.9 |
| Children 1-2 years | 0.00020 | 17 | 0.00006 | 33 | 2.0 |
| Children 3-5 years | 0.00019 | 16 | 0.00005 | 31 | 2.2 |
| Children 6-12 years | 0.00013 | 11 | 0.00004 | 21 | 3.1 |
| Youth 13-19 years | 0.00010 | 8 | 0.00003 | 16 | 4.1 |
| Adult 20-49 years | 0.00013 | 11 | 0.00004 | 21 | 3.2 |
| Adult 50+ years | 0.00014 | 11 | 0.00004 | 22 | 3.0 |
| Females 13-49 years | 0.00013 | 11 | 0.00004 | 21 | 3.2 |

ACP = acephate, MOM = methamidophos, ADI = acceptable daily intake, ARI = aggregate risk index

[1] Acceptable daily intake for acephate = 0.0012 mg/kg bw/day

[2] Acceptable daily intake for methamidophos = 0.00017 mg/kg bw/day

### Table 6 Chronic Acephate and Methamidophos Exposure and Risk Estimates for Food and Drinking Water – Refined

| Population Groups | ACP Exposure- Food and Water Refined[1] | | MOM Exposure-Food and Water Refined[1] | | ARI |
|---|---|---|---|---|---|
| | mg/kg bw/day | % ADI[2] | mg/kg bw/day | % ADI[3] | |
| General Population | 0.00002 | 1 | 0.000003 | 2 | 32 |
| All Infants (<1 years) | 0.00003 | 3 | 0.000004 | 2 | 20 |
| Children 1-2 years | 0.00002 | 2 | 0.000004 | 2 | 24 |
| Children 3-5 years | 0.00002 | 2 | 0.000004 | 2 | 25 |
| Children 6-12 years | 0.00002 | 1 | 0.000003 | 2 | 33 |
| Youth 13-19 years | 0.00001 | 1 | 0.000002 | 1 | 48 |
| Adult 20-49 years | 0.00002 | 1 | 0.000003 | 2 | 32 |
| Adult 50+ years | 0.00002 | 1 | 0.000003 | 2 | 32 |
| Females 13-49 years | 0.00002 | 1 | 0.000003 | 2 | 33 |

Acephate = acephate, MOM = methamidophos, ADI = acceptable daily intake, ARI = aggregate risk index

[1] Refined water estimates include consideration of mitigation measures and refinements to the modelled drinking water residues.

[2] Acceptable daily intake for acephate = 0.0012 mg/kg bw/day

[3] Acceptable daily intake for methamidophos = 0.00017 mg/kg bw/day

# Appendix VIII Supplemental Maximum Residue Limit Information—International Situation and Trade Implications

MRLs may vary from one country to another for a number of reasons, including differences in pesticide use patterns and the locations of the field crop trials used to generate residue chemistry data. For animal commodities, differences in MRLs can be due to different livestock feed items and practices. The American tolerances and the CODEX MRLs for acephate and methamidophos are listed in Tables 2 and 3.

Methamidophos is a major metabolite of acephate and was registered independently as an active ingredient. Methamidophos MRLs were previously established for methamidophos uses. As all methamidophos uses are being phased out, the MRLs for methamidophos will be modified to account for acephate uses. Therefore, the residue definition for acephate for enforcement purposes will be acephate and methamidophos with individual MRLs listed for each compound.

Several MRL changes for acephate and/or methamidophos are proposed as a result of the re-evaluation. These proposals are indicated in the Table 1 and discussed below.

- The revocation of acephate and methamidophos MRLs on succulent beans is proposed to mitigate risk concerns and to account for the phase out of succulent bean use in the United States. No change to the MRL on dry beans is required.

- The revocation of the methamidophos MRL on tomatoes is proposed to mitigate risk concerns. The risk is driven by residues found on imported tomatoes, which is likely the result of methamidophos uses. Quantifiable residues of acephate and methamidophos are not expected to be present on/in tomatoes as a result of the acephate registration as acephate is only allowed for use on tomatoes during the transplanting period.

- The revocation of the MRL on potatoes is proposed as potato use was removed from the water modelling to reduce drinking water modelled EECs.

- The revocation of methamidophos MRLs on broccoli, cucumber, and eggplants is proposed to account for the discontinuation of methamidophos uses in Canada and the United States as acephate is not registered for use on these crops.

- The revocation of the MRLs for leaf lettuce and all varieties of corn except sweet and seed corn is proposed to reflect the use pattern for acephate in Canada. These crops are not registered on the acephate label. The label specifies use on head lettuce and sweet and seed corn.

- The revocation of the acephate MRL for milk is proposed as crops treated with acephate are prohibited from being fed to livestock.

Under the North American Free Trade Agreement, Canada, the United States and Mexico are committed to resolving MRL discrepancies to the broadest extent possible. Harmonization will standardize the protection of human health across North America and promote the free trade of safe food products. Until harmonization is achieved, the Canadian MRLs and regulatory amendments presented in this document are necessary. The differences in MRLs/Tolerances outlined below are not expected to impact businesses negatively or adversely affect international competitiveness of Canadian firms or to negatively affect any regions of Canada.

### Table 1 Acephate and Methamidophos MRLs and Proposed Changes

| Commodity | ACP MRL (ppm) | MOM MRL (ppm) | Proposed MRL Change | |
|---|---|---|---|---|
| | | | ACP | MOM |
| Beans[1] | 1.0 | 0.3 | Change to Dry Beans | Change to Dry Beans |
| Broccoli | -* | 1.0 | _ | Revoke MRL |
| Brussels Sprout | 1.5 | 1.0 | _ | _ |
| Cabbages | 0.3 | 0.5 | _ | _ |
| Cauliflowers | 2.0 | 0.5 | _ | _ |
| Celery | 5.0 | 0.5 | _ | _ |
| Corn | 0.5 | -* | Change to Sweet Corn Kernels plus Cob with Husks | – |
| Cranberries | 0.5 | -* | _ | _ |
| Cucumbers | -* | 0.5 | _ | Revoke MRL |
| Eggplants | -* | 0.5 | _ | Revoke MRL |
| Lettuce | 1.0 | 1.0 | Change to Head Lettuce | Change to Head Lettuce |
| Milk | 0.05 | -* | _ | _ |
| Peppers | 2.0 | 1.0 | _ | _ |
| Potatoes | 0.5 | 0.1 | Revoke MRL | Revoke MRL |
| Saskatoon berries (Juneberries) | 0.03 | -* | – | – |
| Soybeans | 0.5 | -* | _ | _ |
| Tomatoes[2] | -* | 0.5 | _ | Revoke MRL |

ACP = acephate, MOM = methamidophos.

-* = Regulated under Subsection B.15.002 (1) of the *Food and Drugs Act*. This requires that residues do not exceed 0.1 ppm and has been considered a general MRL for enforcement purposes.

[1] For import purposes

[2] Residues of methamidophos may potentially be present in tomatoes due to acephate use on tomatoes during transplanting. However, the residue level is expected to be low and below the general MRL of 0.1 ppm.

### Table 2 Acephate and Methamidophos US Tolerances

| Commodity | Acephate US Tolerance (ppm)[1] | Methamidophos US Tolerance (ppm)[2] |
|---|---|---|
| Bean, dry, seed | 3.0 | 1 |
| Bean, succulent | 3.0 | 1 |
| Brussels Sprout | 3.0 | 0.5 |
| Cattle, fat | 0.01 | - |
| Cattle, meat | 0.1 | - |
| Cattle, meat byproducts | 0.1 | - |
| Cauliflower | 2.0 | 0.5 |

| Commodity | Acephate US Tolerance (ppm)[1] | Methamidophos US Tolerance (ppm)[2] |
|---|---|---|
| Celery | 10 | 1 |
| Cotton, hulls | 1.0 | - |
| Cotton, meal | 1.0 | - |
| Cotton, underlinted seed | 0.5 | - |
| Cranberry | 0.5 | 0.1 |
| Egg | 0.1 | - |
| Goat, fat | 0.1 | - |
| Goat, meat | 0.1 | - |
| Goat, meat byproducts | 0.1 | - |
| Hog, fat | 0.1 | - |
| Hog, meat | 0.1 | - |
| Hog, meat byproducts | 0.1 | - |
| Horse, meat byproducts | 0.1 | - |
| Lettuce, head | 10 | 1 |
| Milk | 0.1 | - |
| Peanut | 0.2 | - |
| Peppers | 4.0 | 1 |
| Peppermint, tops | 27 | 1 |
| Poultry, fat | 0.1 | - |
| Poultry, meat | 0.1 | - |
| Poultry, meat byproducts | 0.1 | - |
| Sheep, fat | 0.1 | - |
| Sheep, meat | 0.1 | - |
| Sheep, meat byproducts | 0.1 | - |
| Spearmint, tops | 27 | 1 |
| Soybean, seed | 1.0 | - |
| Nut, macadamia | 0.05 | - |

Blank (-) = not established

[1] As per Title 40 Part 180.261 of the United States Code of Federal Regulations. A Tolerance of 0.02 ppm is established for residues of acephate in or on all food items (other than those already covered by a higher tolerance as a result of use on growing crops) in food handling establishments where food and food products are held, processed, prepared and served. Acephate Tolerances can be accessed on the Electronic Code of Regulations website. Last accessed December 18, 2012.

[2] Methamidophos tolerances resulting from methamidophos uses are not presented. All methamidophos specific tolerances are to be revoked by the end of 2014.

## Table 3 Acephate and Methamidophos Codex MRLs

| Commodity | Acephate Codex MRL (ppm)[1] | Methamidophos Codex MRL (ppm) |
|---|---|---|
| Artichoke, globe | 0.3 | 0.2 |
| Beans, except broad and soya | 5 | 1 |
| Cabbages, head | 2 | - |
| Cotton seed | - | 0.2 |
| Cranberry | 0.5 | |
| Edible offal (mammalian) | 0.05 | 0.01 |
| Eggs | 0.01 | 0.01 |
| Fodder beet | - | 0.02 |
| Meat (from mammals other than marine mammals) | 0.05 | 0.01 |
| Milks | 0.02 | 0.02 |
| Pepper Chili, dried | 50 | - |

| Commodity | Acephate Codex MRL (ppm)[1] | Methamidophos Codex MRL (ppm) |
|---|---|---|
| Potato | - | 0.05 |
| Poultry fats | 0.1 | - |
| Poultry meat | 0.01 | 0.01 |
| Poultry, edible off of | 0.01 | 0.01 |
| Soya bean (dry) | - | 0.1 |
| Spices | 0.02 | 0.1 |
| Sugar beet | - | 0.02 |
| Tomato | 1 | - |

Blank (-) = not established

[1] Codex is an international organization under the auspices of the United Nations that develops international food standards, including MRLs. The CODEX MRLs can be found on Codex website. Last accessed December 18, 2012.

## Table 4 Residue Definition in Canada and Other Jurisdictions

| Jurisdiction | Residue Definition | |
|---|---|---|
| Canada | RD for risk assessment | Acephate and Methamidophos |
| | RD for enforcement | Acephate and Methamidophos* |
| United States | RD for risk assessment | Acephate and Methamidophos |
| | RD for enforcement | Acephate and Methamidophos* |
| CODEX (JMPR) | RD for risk assessment | Acephate and Methamidophos |
| | RD for enforcement | Acephate |

RD = residue definition

IUPAC name for Acephate is *O,S*-dimethyl acetyl phosphoramidothioate.

IUPAC name for Methamidophos is *O,S*-dimethyl phosphoramidothioate

* Acephate and methamidophos MRLs are established separately to account for acephate use.

# Appendix IX Environmental Fate, Toxicity and Risk Assessment

## Table 1 Fate and Behaviour of Acephate in the Terrestrial and Aquatic Environment

| Property | Test substance | Value | Transformation products | Comments | Reference |
|---|---|---|---|---|---|
| **Abiotic transformation** | | | | | |
| Hydrolysis | Technical | $t_{1/2}$ = 60 d at pH 5, 7<br>$t_{1/2}$ =16-18 d at pH 9 | methamidophos, DMTP | Not an important route of transformation | PMRA 1208108<br>PMRA 1208112<br>PMRA 2132434<br>PMRA 2131251<br>PMRA 2131268 |
| Phototransformation on soil | | Stable | - | | |
| Phototransformation in water | | Stable | - | | |
| **Biotransformation** | | | | | |
| Biotransformation in aerobic soil | Technical | $t_{1/2}$ =1-2 d | methamidophos, DMTP | Non persistent | PMRA 1181142<br>PMRA 1208119<br>PMRA 2132434<br>PMRA 2131251<br>PMRA 2131268<br>PMRA 1181144 |
| Biotransformation in anaerobic soil | | $t_{1/2}$ <7d | - | - | |
| Biotransformation in aerobic water | | | - | No data available | |
| Biotransformation in anaerobic water | | $t_{1/2}$ =6.6 d | Not identified | Non persistent | |
| **Mobility** | | | | | |
| Adsorption/ desorption in soil | Technical | $K_f$ of 0.09 (clay loam)<br>$K_{oc}$ of 2.7 | - | Highly mobile | PMRA 2132434<br>PMRA 2131251<br>PMRA 2131268 |
| Volatilization | | $1.7\times 10^{-6}$ mm Hg at 24°C<br>$2.26\times 10^{-4}$ Pa | - | Non volatile | |
| **Field studies** | | | | | |
| Field dissipation | Formulated product | $DT_{50}$ of 1.8 d (acephate)<br>$DT_{50}$ of 2.9 d (methamidophos) | - | Non persistent. No detection below 30 cm | PMRA 1142212 |

## Table 2 Acephate Toxicity to Non-Target Species

| Organism | Exposure | Test substance | Endpoint value | Degree of toxicity | Reference |
|---|---|---|---|---|---|
| **Invertebrates** | | | | | |
| Bee | Acute contact | Technical | $LD_{50}$ = 1.2 µg a.i./bee | Highly toxic | PMRA 2132434<br>PMRA 2131251<br>PMRA 2131268 |
| Earthworm | Acute | | $LD_{50}$> 10000 mg a.i./kg soil | - | |
| **Birds** | | | | | |
| Mallard duck | Acute | Technical | $LD_{50}$ = 234-350 mg a.i./kg bw | Moderately toxic | PMRA 2132434<br>PMRA 2131251<br>PMRA 2131268<br>PMRA 1208131<br>PMRA 1208133<br>PMRA 1208134<br>PMRA 1208135<br>PMRA 1208138<br>PMRA 1208137 |
| | Dietary | | $LC_{50}$ >5000 mg a.i./kg diet | Practically non-toxic | |
| | Reproduction | | NOAEC/LOEC =5/20 mg a.i./kg d | - | |
| Bobwhite quail | Acute | | $LD_{50}$ = 109 mg a.i./kg bw | Moderately toxic | |
| | Dietary | | $LC_{50}$ =1280 mg a.i./kg diet | Slightly toxic | |
| | Reproduction | | NOEC/LOEC=20/80 mg a.i./kg diet | - | |
| Pheasant | Acute | | $LD_{50}$ = 140 mg a.i./kg diet | Moderately toxic | |
| Junco | Acute | | $LD_{50}$ = 106 mg a.i./kg diet | Moderately toxic | |
| **Mammals** | | | | | |
| Rat | Acute | Technical | $LD_{50}$ = 1/1.4 g a.i./kg bw (♀/♂) | Slightly toxic | PMRA 2132434 |

| Organism | Exposure | Test substance | Endpoint value | Degree of toxicity | Reference |
|---|---|---|---|---|---|
| | Reproduction | | NOEL = 50 mg a.i./kg/d | - | PMRA 2131251<br>PMRA 2131268 |
| Mouse | Acute | Technical | LD$_{50}$ = 321 mg a.i./kg bw | Moderately toxic | |
| **Freshwater species** | | | | | |
| *Daphnia magna* | Acute | Technical | LC$_{50}$ = 1.3 – 67 mg a.i./L | Moderately to slightly toxic | PMRA 2132434<br>PMRA 2131251<br>PMRA 2131268<br>PMRA 1208161<br>PMRA 1181149 |
| | Chronic | | NOEC= 0.15 mg a.i./L | - | |
| Scud | Acute | | LC$_{50}$ = 50-100 mg a.i./L | Practically non-toxic | |
| Midge | Acute | | LC$_{50}$ > 1000 mg a.i./L | | |
| Rainbow trout | Acute | | LC$_{50}$ = 110- 1000 mg a.i./L | | |
| | Chronic | | NOEC = 100 mg a.i./L | - | |
| Bluegill sunfish | Acute | | LC$_{50}$ > 1000 mg a.i./L | Practically non-toxic | |
| Freshwater alga | Acute | | NOEC=72 mg a.i./L (cell density)<br>NOEC= 24 mg a.i./L (biomass) | - | |
| **Marine species** | | | | | |
| Mysid shrimp | Acute | Technical | LC$_{50}$ = 73 mg a.i./L | Moderately toxic | PMRA 2132434<br>PMRA 2131251<br>PMRA 2131268<br>PMRA 1208169 |
| | Chronic | | NOAEC/LOAEC=0.58/1.4mg a.i./L | - | |
| Eastern oyster | Acute | | EC$_{50}$ = 150 mg a.i./L | Practically non-toxic | |
| Sheepshead minnow | Acute | | LC$_{50}$ = 9100 mg a.i./L | Practically non-toxic | |

## Table 3 Methamidophos Toxicity to Non-target Species

| Organism | Study type | Test material | Endpoint Value | Degree of toxicity | Reference |
|---|---|---|---|---|---|
| **Invertebrates** | | | | | |
| Honeybee | Acute contact | Technical | 48-h LD$_{50}$ = 1.37 µg a.i./bee | Highly toxic | PMRA 1658043 |
| Earthworm | | | 14-d LC$_{50}$ = 34 mg a.i./kg soil | - | PMRA 1192469 |
| **Birds** | | | | | |
| Mallard duck | Acute | Technical | LD$_{50}$ = 8.5 mg a.i./kg bw | Very highly toxic | PMRA 1658043<br>PMRA 1658045 |
| Bobwhite quail | | | LD$_{50}$ = 8 mg a.i./kg bw | | |
| European starling | | | LD$_{50}$ = 10 mg a.i./kg bw | Highly toxic | |
| Mallard duck | Dietary | | LC$_{50}$ = 847 mg a.i./kg diet | Moderately toxic | |
| Japanese quail | | | LC$_{50}$ = 92 mg a.i./kg diet | Highly toxic | |
| Bobwhite quail | | | LC$_{50}$ = 42 mg a.i./kg diet | Very highly toxic | |
| Bobwhite quail | Reproduction | | NOEC = 3 mg a.i./kg diet | - | |
| Mallard duck | | | NOEC >15 mg a.i./kg diet | - | |
| **Mammals** | | | | | |
| Rat | Acute oral | Technical | LD$_{50}$ = 13 mg a.i./kg bw | Highly toxic | PMRA 1658043<br>PMRA 1658045 |
| Mouse | | | LD$_{50}$ = 16 mg a.i./kg bw | | |
| Rabbit | | | LD$_{50}$ = 118 mg a.i./kg bw | Moderately toxic | |
| Mouse | Reproduction | | NOEL = 10 mg a.i./kg bw/day | - | |
| Rat | Dietary | | NOEL = 0.12 mg a.i./kg bw/day | - | PMRA 2141830 |

| Organism | Study type | Test material | Endpoint Value | Degree of toxicity | Reference |
|---|---|---|---|---|---|
| **Freshwater Species** | | | | | |
| *Daphnia magna* | Acute | Technical | 48-h $EC_{50}$ = 0.026 mg a.i./L | Very highly toxic | PMRA 1658043<br>PMRA 1658045 |
| Rainbow trout | Acute | | 96-h $LC_{50}$ = 25 mg a.i./L | Slightly toxic | |
| Bluegill sunfish | | | 96-h $LC_{50}$ = 34 mg a.i./L | | |
| **Marine Species** | | | | | |
| Eastern oyster | Acute | Technical | 96-h $LC_{50}$ = 36 mg a.i./L | Slightly toxic | PMRA 1658043 |
| Mysid shrimp | | | 96-h $LC_{50}$ = 1.05 mg a.i./L | Moderately toxic | |
| Sheepshead minnow | | | 96-h $LC_{50}$ = 5.6 mg a.i./L | | |

## Table 4a Risk Assessment for Eathworms.

| Organism | Exposure | Endpoint value | Applic. Rate (kg a.i./ha) | EEC[1] | RQ[2] | LOC[3] exceeded | Reference |
|---|---|---|---|---|---|---|---|
| **Acephate** | | | | | | | |
| Earthworm | Acute contact | $LC_{50}$ > 1000 mg a.i./kg | 1.275 | 0.57 mg a.i./kg soil | <0.1 | No | (EPA RED)<br>1598965<br>2131268 |
| | | | | | | | |
| **Methamidophos** | | | | | | | |
| Earthworm | Acute contact | $LC_{50}$ = 34 mg a.i./kg | 0.425[4] | 0.2 mg a.i./kg soil | <0.1 | No | |
| | | | | | | | |

[1] Environmental Exposure Concentration (Soil: calculated based on a soil density of 1.5 g/cm$^3$, soil depth of 15 cm and the label rates taking into consideration dissipation between applications; Bee: maximum individual application rate.

[2] Risk Quotient (RQ) = exposure/toxicity

[3] Level of Concern (LOC) = RQ = 1

[4] Cumulative rate (four applications @ 328 g a.i./ha with 7d interval) calculated from molecular ratio methamidophos/acephate (0.77) with assumption that 100% acephate application rate is an equivalent of 50% methamidophos rate.

**Table 4b Pollinator Risk Summary, including higher tier studies obtained from open literature**

| Species | Test item | Exposure | Endpoint value | Applic. Rate (kg a.i./ha) | EEC[1] | RQ | LOC exceeded[2] | Reference |
|---|---|---|---|---|---|---|---|---|
| **Study summaries from external reviews** | | | | | | | | |
| **Tier I (laboratory studies)** | | | | | | | | |
| Bee | acephate | Acute contact | $LD_{50}$ = 1.2 µg a.i./bee | 1.3 | 3.12 | 2.6 | Yes | **(EPA RED) PMRA 1598965, 2131268** |
| Bee | Methamidophos (transformation product of acephate) | Acute contact | $LD_{50}$ = 1.37 µg a.i./bee | 0.425 | 1.02 | 0.74 | Yes | |
| **Foliage residue studies** | | | | | | | | |
| **Species** | **Test item** | **Application rate** | | **No. hrs. after initial exposure(a) and % dead after contact** | | | | **(EPA RED) PMRA 1598965, 2131268**<br>http://www.epa.gov/espp/litstatus/effects/redleg-frog/acephate/appendicies.pdf |
| honeybee (*Apis mellifera*) | 75 % TGAI | Foliage residue study, application at 453 grams ai | | 0 hr. = 100 2 hr. = 79 8 hr. = 17 | | | | |
| alkali bee (*Nomia melanderi*) | 75 % TGAI | Foliage residue study, application at 453 grams a.i. | | 2 hr. = 83 8 hr. = 30 | | | | |
| alfalfa leaf cutter bee (*Megachile rotundata*) | 75 % TGAI | Foliage residue study, application at 453 grams a.i. | | 2 hr. = 69 8 hr. = 21 | | | | |
| bumble bee | 75 % TGAI | Foliage residue study, application at 453 grams a.i. | | 2hr. = 43 | | | | |
| honeybee (*Apis mellifera*) | 75 % TGAI | Foliage residue study, application at 453 grams a.i. | | 2 hr. = 79 8 hr. = 16 | | | | |
| alkali bee (*Nomia melanderi*) | 75 % TGAI | Foliage residue study, application at 453 grams a.i. | | 2 hr. = 81 8 hr. = 23 | | | | |
| honeybee (*Apis mellifera*) | orthene | Foliage residue study, application at 217 grams a.i. | | 1 hr. = 4.5 24 hr. = 98.5 96 hr. = 5.0 | | | | |
| honeybee (*Apis mellifera*) | orthene | Foliage residue study, application at 439 grams ai | | 1 hr. = 3.2 24 hr. = 100 96 hr. = 41.7 | | | | |

| Species | Test item | Exposure | Endpoint value | Applic. Rate (kg a.i./ha) | EEC[1] | RQ | LOC exceeded[2] | Reference |
|---|---|---|---|---|---|---|---|---|
| **Other study summaries** | | | | | | | | |
| Acephate appears to be systemic in nurse bees, causing glandular secretions fed to queens to be toxic. All colonies fed the 10 ppm rate lost queens early in the study and the affected colonies were unable to rear new queens. The study implied infrequent encounters by honeybee foragers with acephate on crops at levels of 1 ppm (1 ppm is NOAEC level) or less should be harmless. However, foragers may be expected to encounter levels greater than 1 ppm in the field because of 6 to 9 day residue persistence and residual systemic activity of acephate in plants for up to 15 days. Consequently, the study concluded that acephate is a hazard to honeybees because of its high contact toxicity, and because of its systemic nature. | | | | | | | | **PMRA 1598965, 2131268**<br>http://www.epa.gov/espp/litstatus/effects/redleg-frog/acephate/appendicies.pdf<br>**(Stoner et al., 1984)** |
| Orthene was found to be more detrimental to honeybee populations than carbaryl. Brood cycles of some colonies were found to be permanently broken, so the colonies were technically dead. Depression in the numbers of wild foraging bees was apparent. Measured seed and fruit production of various plants were reduced from lack of pollination. | | | | | | | | **PMRA 1598965, 2131268**<br>http://www.epa.gov/espp/litstatus/effects/redleg-frog/acephate/appendicies.pdf<br>**(Johansen, 1977)** |
| Severe impacts on yellow jacket wasps and ants at rates of application of 1 and 2 lb a.i./A sprayed on forest. Temperature seems to affect the exposure of wasps in that cooler temperature (39°F) causes wasps not to forage out of nests and therefore not be exposed as much, whereas warmer temperatures (59°F) increases the activity of wasps and the exposure to acephate. | | | | | | | | **PMRA 1598965, 2131268**<br>http://www.epa.gov/espp/litstatus/effects/redleg-frog/acephate/appendicies.pdf<br>**(Johansen, 1977)** |
| Information submitted during the 60-day comment period for the Acephate RED (Johansen, 1999) indicated that acephate is hazardous to honeybees, alkali bees and alfalfa leaf-cutting bees for 3 days when applied to blooming crops or weeds. Washington State Department of Agriculture investigated approximately 135 bee kills from 1992 to 1998. In several cases, acephate was responsible for killing honeybees when it was applied to blooming mint. There were seven incidents in Washington State in which bee colonies were adversely impacted from the use of acephate on nearby mint and carrot fields. Acephate residues on bees were detected in all of these incidents in concentrations up to 2.63 ppm. Apiary losses ranged up to 60 hives per incident. | | | | | | | | **PMRA 1598965, 2131268**<br>http://www.epa.gov/espp/litstatus/effects/redleg-frog/acephate/appendicies.pdf |
| Acephate fed to worker bees at 0.1 ppm showed reduction of surviving brood | | | | | | | | **PMRA 1598965, 2131268**<br>http://www.epa.gov/espp/litstatus/effects/redleg-frog/acephate/appendicies.pdf |

| Species | Test item | Exposure | Endpoint value | Applic. Rate (kg a.i./ha) | EEC[1] | RQ | LOC exceeded[2] | Reference |
|---|---|---|---|---|---|---|---|---|
| For most of the systemic substances the residues ranged from 0.02 mg kg$^{-1}$ aldicarb (Knapp and Ansonmoye, 1988) to 8 mg kg$^{-1}$ acephate (Fiedler and Drescher, 1984).<br>Effects on adults:<br>Laboratory feeding tests showed that low concentrations of systemic compounds for example, 0.25 mg kg$^{-1}$ dimethoate, acephate or methamidophos applied to adults and causing no acute mortality, killed 50% of the bees exposed for two weeks to contaminated sugar solutions (Fiedler, 1987a). | | | | | | | | **PMRA 2550596** |

[1] For bees, EECs are now calculated by multiplying application rate (1.3 kg a.i./ha) by the contact exposure estimate for bees (2.4 µg a.i./bee/day for adults).

[2] The LOC for acute pollinator studies is 0.4 and for chronic pollinator studies is 1.0

| **Higher tier pollinator studies (open literature)** | | | |
|---|---|---|---|
| **Species** | **Study design** | **Results** | **Reference** |
| Honeybees | The study was designed to examine if snap beans are a food resource for honeybees, and also the effects of acephate and methyl parathion on honeybees from treated food. Snap beans were treated aerially in 1983 and 1984 with either a control, or methyl parathion or acephate (at 1.1 kg a.i./ha, applied at 13 days (1983) and 23 days (1984) before harvest). Sister queen colony hives (between five and eight colonies per site) which were equalized prior to exposure were placed in fields at 44 and 37 days after planting (1983 and 1984, respectively). | **Summary:** Mortality in bees exposed to beans treated with acephate did not differ from control mortality (dead bees ranged from 16 to 104 dead bees per colony per day in acephate colonies and from 10 to 150 per colony per day in control). However, the study also concluded that bees did not forage on the treated bean fields.<br>Mortality was higher in the methyl parathion treated fields, which resulted from foraging on blooming weeds in the field or among glowering plants within the spray drift zone (and not the treated bean plants).<br>**Uncertainties/Limitations**:<br>The study concluded that bees did not visit beans, and therefore, there was likely limited exposure to acephate in this study.<br>The rates for acephate fall within Canadian registered rates.<br>The control fields in 1983 were not beans. They were composed of corn and alfalfa. Therefore, different nutrition and pollen/nectar sources could have resulted in different hive development. | PMRA 2550597 |

| Higher tier pollinator studies (open literature) | | | |
|---|---|---|---|
| **Species** | **Study design** | **Results** | **Reference** |
| | | Colonies with inadequate honey stores for winter survival were fed sugar syrup. It is unclear which hives were treated.<br>It was concluded that there was no statistical difference in the mortality between acephate and control hives; however, treatment hive mortality was 104 dead bees on day two, compared to 15 dead bees in the control. In 1983 mortality was higher in the acephate hives, and in 1984 mortality was higher in the control hives. Differences in pollen/nectar quantity and quality could have contributed to the mortality as well, given that control hives were not exposed to beans in 1983. | |
| Honeybee | Residue determination in nectar from orchard crops (apple, raspberry and cherry) treated at 750 g a.i./ha prebloom and during bloom, and effects study with dosed hives (feeding study) at 0, 0.25, 0.5, and 1 ppm of contaminated sugar syrup. | **Residues:** Applications made one day before flowering resulted in residues ranging from 1.4 ppm in apple trees sampled seven days after flowering, up to 14.39 ppm in cherry trees sampled one day after beginning of flowering. The lowest residues were 0.15 in raspberry treated 13 days before flowering and sampled 6 days after beginning of flowering. The highest residues were found in the cherry trees (14.39 ppm). Applications made at seven days prebloom and sampled from seven to nine days after flowering in apple trees still resulted in resdicus of 2.93 and 1.67 ppm, respectively. A prebloom application of nine days (to cherry trees) and sampled the first of bloom resulted in 0.85 ppm in nectar. Overall, the closer to bloom the application was made, the higher the residues. Residues appear to persist in nectar for long time periods post application.<br>**Effects:** The study concluded that concentrations as low as 0.25 ppm affected number of eggs (42.2), larvae (6) and pupae (0.6) compared to control | PMRA 2550598 |

| Higher tier pollinator studies (open literature) | | | |
|---|---|---|---|
| **Species** | **Study design** | **Results** | **Reference** |
| | | (eggs: 229.2, larvae: 196, and pupae: 200). Survival of bees (%) was similar between control and treatment doses (0.25 and 0.5 ppm)(ranging from 72.5 to 89.5%), however, at 1 ppm, survival was statistically lower (23.9% survival). Overall, some effects to brood were observed at concentrations as low as 0.25 ppm, and overall survival was affected at 1 ppm.<br>In comparison residues from application timing to effects in the feeding study, it is concluded that pre-bloom applications can affect bees. Applications at 750 g a.i./ha applied nine days prebloom resulted in residues < 1 ppm (which is the level at which survival was significantly reduced in the study).<br>**Uncertainties/Limitations**:<br>Uncertainties include that the application rate in the study was lower than the single maximum rate for crops in Canada;<br>There was no dilution of the concentration, which may overestimate realistic field exposure;<br>There was a lack of replicates. | |
| Africanized honey bees (*Apis mellifera scutellata* L.) | Africanized honey bees were baited to feeders containing syrup containing 500 ppm acepahte (Orthene 75 S) in the field. Residues of acephate and methamidophos were measured in dead bees and honey-beeswax matrix from five colonies. | **Summary:** Colonies collected an average of 30 mg acephate and 34 of 35 colonies died after treatment at distances from 88 to 1000 m away from the hives. The study indicated that the effective dose is low compared to recommended rates. For example, 30 mg is 1/50 to 1/150 the amount of acephate (2 to 6 g (up to one table spoon of Orthene 75S labeled for red fire ants.<br>In addition, residues of acephate were higher than methamidophos, and both compounds were higher in dead bees than in honey-wax-matrix. Acephate levels in dead bees peaked near 10 ppm after one day | PMRA 2550595 |

| Higher tier pollinator studies (open literature) | | | |
|---|---|---|---|
| **Species** | **Study design** | **Results** | **Reference** |
| | | treatment and decline to 1 ppm 10 weeks later.<br>**Uncertainties/Limitations**:<br>Uncertainties and limitation include the rates used in the study compared to registered rates. Five hundred parts per million in sugar solution appears to be extremely high compared to the residues detected in other studies from field applications.<br>The study employed the Africanized honeybee.<br>The use pattern was not directly comparable to the current use pattern being evaluated for field agricultural and non-agricultural uses.<br>Lower density colonies and nectar scarcity could impact exposure and effects. | |

[1] For bees, EECs are now calculated by multiplying application rate (1.275 kg a.i./ha) by the contact exposure estimate for bees (2.4 µg a.i./bee/day for adults).

### Table 5 Risk assessment for Aquatic Organisms from Acephate Exposure

| Organism | Exposure | Endpoint value[1] | Applic. Rate (kg a.i./ha) | EEC[2] | RQ | LOC exceeded |
|---|---|---|---|---|---|---|
| **Freshwater** | | | | | | |
| *Daphnia magna* | Acute | ½$LC_{50}$=0.65 mg a.i./L | 1.275 | 0.16 mg a.i./L | 0.25 | No |
| | Chronic | NOEC=0.15 mg a.i./L | | | 1.1 | Yes |
| Rainbow trout | Acute | 1/10$LC_{50}$ = 11 mg a.i./L | | | < 0.1 | No |
| | Chronic | NOEC = 100 mg a.i./L | | | < 0.1 | No |
| Freshwater alga | Acute | NOEC = 24 mg a.i./L | | | < 0.1 | No |
| Amphibians[3] | Acute | 1/10$LC_{50}$ = 11 mg a.i./L | | 0.85 mg a.i./L | < 0.1 | No |
| **Marine /Estuarine** | | | | | | |
| Mysid shrimp | Acute | ½$LC_{50}$=36.5 mg a.i./L | 1.275 | 0.16 mg a.i./L | < 0.1 | No |
| | Chronic | NOEC=0.58 mg a.i./L | | | 0.3 | No |
| Sheepshead minnow | Acute | $LC_{50}$ = 9100 mg a.i./L | | | < 0.1 | No |

[1] Endpoints for acute exposure were divided by an Uncertainty Factor of 2 (invertebrates) and 10 (fish and amphibians) to account for varying protection goals (for example, protection at the community, population or individual level).

[2] 15 and 80 cm depth of water for amphibians and other organisms, respectively.

[3] Toxicity values from fish as surrogate

### Table 6 Risk assessment for Aquatic Organisms from Methamidophos Exposure

| Organism | Exposure | Endpoint value[1] | Applic. Rate[4] (kg a.i./ha) | EEC[2] | RQ | LOC exceeded |
|---|---|---|---|---|---|---|
| **Freshwater** | | | | | | |
| *Daphnia magna* | Acute | 1/2$LC_{50}$=0.013 mg a.i./L | 0.425 | 0.06 mg a.i./L | 4.6 | Yes |
| Rainbow trout | Acute | 1/10$LC_{50}$ = 2.5 mg a.i./L | | | < 0.1 | No |
| | Chronic | NOEC = 100 mg a.i./L | | | < 0.1 | No |
| Amphibians[3] | Acute | 1/10$LC_{50}$ = 2.5 mg a.i./L | | 0.33 mg a.i./L | 0.1 | No |
| Marine /Estuarine | | | | | | |
| Mysid shrimp | Acute | 1/2$LC_{50}$= 0.1 mg a.i./L | 0.425 | 0.06 mg a.i./L | 0.6 | No |
| | Chronic | NOEC= 0.58 mg a.i./L | | | 0.1 | No |
| Sheepshead minnow | Acute | 1/10$LC_{50}$ = 0.56 mg a.i./L | | | 0.1 | No |

[1] Endpoints for acute exposure were divided by an Uncertainty Factor of 2 (invertebrates) and 10 (fish and amphibians) to account for varying protection goals (i.e., protection at the community, population or individual level).

[2] 15 and 80 cm depth of water for amphibians and other organisms, respectively.

[3] Toxicity values from fish as surrogate

[4] Rate of 1.275 kg a.i./ha re-calculated from acephate to methamidophos (molecular ratio 0.77) with assumption that 100% acephate an equivalent of 50% methamidophos

## Table 7 Acephate Risk Assessment for Birds[1]

| | | | Maximum nomogram residues | | | | Mean nomogram residues | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On-field | | Off-field | | On-field | | Off-field | |
| | Toxicity (mg a.i./kg bw/d) | Food Guild (food item) | EDE (mg a.i./kg bw) | RQ | EDE (mg a.i./kg bw) | RQ | EDE (mg a.i./kg bw) | RQ | EDE (mg a.i./kg bw) | RQ |
| **Small Bird (0.02 kg)** | | | | | | | | | | |
| Acute | 10.90 | Insectivore (small insects) | 55.59 | 5.10 | 6.12 | 0.56 | 31.00 | 2.84 | 3.41 | 0.31 |
| | 10.90 | Granivore (grain and seeds) | 13.90 | 1.28 | 1.53 | 0.14 | 6.63 | 0.61 | 0.73 | 0.07 |
| | 10.90 | Frugivore (fruit) | 27.80 | 2.55 | 3.06 | 0.28 | 13.26 | 1.22 | 1.46 | 0.13 |
| Dietary | 128.00 | Insectivore (small insects) | 55.59 | 0.43 | 6.12 | 0.05 | 31.00 | 0.24 | 3.41 | 0.03 |
| | 128.00 | Granivore (grain and seeds) | 13.90 | 0.11 | 1.53 | 0.01 | 6.63 | 0.05 | 0.73 | 0.01 |
| | 128.00 | Frugivore (fruit) | 27.80 | 0.22 | 3.06 | 0.02 | 13.26 | 0.10 | 1.46 | 0.01 |
| Reproduction | 5.00 | Insectivore (small insects) | 55.59 | 11.12 | 6.12 | 1.22 | 31.00 | 6.20 | 3.41 | 0.68 |
| | 5.00 | Granivore (grain and seeds) | 13.90 | 2.78 | 1.53 | 0.31 | 6.63 | 1.33 | 0.73 | 0.15 |
| | 5.00 | Frugivore (fruit) | 27.80 | 5.56 | 3.06 | 0.61 | 13.26 | 2.65 | 1.46 | 0.29 |
| **Medium Sized Bird (0.1 kg)** | | | | | | | | | | |
| Acute | 10.90 | Insectivore (small insects) | 43.38 | 3.98 | 4.77 | 0.44 | 24.20 | 2.22 | 2.66 | 0.24 |
| | 10.90 | Insectivore (large insects) | 10.85 | 1.00 | 1.19 | 0.11 | 5.17 | 0.47 | 0.57 | 0.05 |
| | 10.90 | Granivore (grain and seeds) | 10.85 | 1.00 | 1.19 | 0.11 | 5.17 | 0.47 | 0.57 | 0.05 |
| | 10.90 | Frugivore (fruit) | 21.69 | 1.99 | 2.39 | 0.22 | 10.35 | 0.95 | 1.14 | 0.10 |
| Dietary | 128.00 | Insectivore (small insects) | 43.38 | 0.34 | 4.77 | 0.04 | 24.20 | 0.19 | 2.66 | 0.02 |
| | 128.00 | Insectivore (large insects) | 10.85 | 0.08 | 1.19 | 0.01 | 5.17 | 0.04 | 0.57 | 0.00 |
| | 128.00 | Granivore (grain and seeds) | 10.85 | 0.08 | 1.19 | 0.01 | 5.17 | 0.04 | 0.57 | 0.00 |
| | 128.00 | Frugivore (fruit) | 21.69 | 0.17 | 2.39 | 0.02 | 10.35 | 0.08 | 1.14 | 0.01 |
| Reproduction | 5.00 | Insectivore (small insects) | 43.38 | 8.68 | 4.77 | 0.95 | 24.20 | 4.84 | 2.66 | 0.53 |
| | 5.00 | Insectivore (large insects) | 10.85 | 2.17 | 1.19 | 0.24 | 5.17 | 1.03 | 0.57 | 0.11 |
| | 5.00 | Granivore (grain and seeds) | 10.85 | 2.17 | 1.19 | 0.24 | 5.17 | 1.03 | 0.57 | 0.11 |
| | 5.00 | Frugivore (fruit) | 21.69 | 4.34 | 2.39 | 0.48 | 10.35 | 2.07 | 1.14 | 0.23 |
| **Large Sized Bird (1 kg)** | | | | | | | | | | |
| Acute | 10.90 | Insectivore (small insects) | 12.67 | 1.16 | 1.39 | 0.13 | 7.06 | 0.65 | 0.78 | 0.07 |
| | 10.90 | Insectivore (large insects) | 3.17 | 0.29 | 0.35 | 0.03 | 1.51 | 0.14 | 0.17 | 0.02 |
| | 10.90 | Granivore (grain and seeds) | 3.17 | 0.29 | 0.35 | 0.03 | 1.51 | 0.14 | 0.17 | 0.02 |
| | 10.90 | Frugivore (fruit) | 6.33 | 0.58 | 0.70 | 0.06 | 3.02 | 0.28 | 0.33 | 0.03 |
| | 10.90 | Herbivore (short grass) | 45.27 | 4.15 | 4.98 | 0.46 | 16.08 | 1.47 | 1.77 | 0.16 |
| | 10.90 | Herbivore (long grass) | 27.64 | 2.54 | 3.04 | 0.28 | 9.03 | 0.83 | 0.99 | 0.09 |
| | 10.90 | Herbivore (forage crops) | 41.88 | 3.84 | 4.61 | 0.42 | 13.85 | 1.27 | 1.52 | 0.14 |

| | | | **Maximum nomogram residues** | | | | **Mean nomogram residues** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | **On-field** | | **Off-field** | | **On-field** | | **Off-field** | |
| | **Toxicity (mg a.i./kg bw/d)** | **Food Guild (food item)** | **EDE (mg a.i./kg bw)** | **RQ** | **EDE (mg a.i./kg bw)** | **RQ** | **EDE (mg a.i./kg bw)** | **RQ** | **EDE (mg a.i./kg bw)** | **RQ** |
| Chronic | 128.00 | Insectivore (small insects) | 12.67 | 0.10 | 1.39 | 0.01 | 7.06 | 0.06 | 0.78 | 0.01 |
| | 128.00 | Insectivore (large insects) | 3.17 | 0.02 | 0.35 | 0.00 | 1.51 | 0.01 | 0.17 | 0.00 |
| | 128.00 | Granivore (grain and seeds) | 3.17 | 0.02 | 0.35 | 0.00 | 1.51 | 0.01 | 0.17 | 0.00 |
| | 128.00 | Frugivore (fruit) | 6.33 | 0.05 | 0.70 | 0.01 | 3.02 | 0.02 | 0.33 | 0.00 |
| | 128.00 | Herbivore (short grass) | 45.27 | 0.35 | 4.98 | 0.04 | 16.08 | 0.13 | 1.77 | 0.01 |
| | 128.00 | Herbivore (long grass) | 27.64 | 0.22 | 3.04 | 0.02 | 9.03 | 0.07 | 0.99 | 0.01 |
| | 128.00 | Herbivore (forage crops) | 41.88 | 0.33 | 4.61 | 0.04 | 13.85 | 0.11 | 1.52 | 0.01 |
| Reproduction | 5.00 | Insectivore (small insects) | 12.67 | 2.53 | 1.39 | 0.28 | 7.06 | 1.41 | 0.78 | 0.16 |
| | 5.00 | Insectivore (large insects) | 3.17 | 0.63 | 0.35 | 0.07 | 1.51 | 0.30 | 0.17 | 0.03 |
| | 5.00 | Granivore (grain and seeds) | 3.17 | 0.63 | 0.35 | 0.07 | 1.51 | 0.30 | 0.17 | 0.03 |
| | 5.00 | Frugivore (fruit) | 6.33 | 1.27 | 0.70 | 0.14 | 3.02 | 0.60 | 0.33 | 0.07 |
| | 5.00 | Herbivore (short grass) | 45.27 | 9.05 | 4.98 | 1.00 | 16.08 | 3.22 | 1.77 | 0.35 |
| | 5.00 | Herbivore (long grass) | 27.64 | 5.53 | 3.04 | 0.61 | 9.03 | 1.81 | 0.99 | 0.20 |
| | 5.00 | Herbivore (forage crops) | 41.88 | 8.38 | 4.61 | 0.92 | 13.85 | 2.77 | 1.52 | 0.30 |

[1] Based on cumulative rate of 1.103 kg a.i./ha (4 applic. @852 g a.i./ha with 7d interval).

Shaded cells indicates exceedance of LOC.

## Table 8 Acephate Risk Assessment for Mammals[1]

| | | | **Maximum nomogram residues** | | | | **Mean nomogram residues** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | **On-field** | | **Off-field** | | **On-field** | | **Off-field** | |
| | **Toxicity (mg a.i./kg bw/d)** | **Food Guild (food item)** | **EDE (mg a.i./kg bw)** | **RQ** | **EDE (mg a.i./kg bw)** | **RQ** | **EDE (mg a.i./kg bw)** | **RQ** | **EDE (mg a.i./kg bw)** | **RQ** |
| **Small Mammal (0.015 kg)** | | | | | | | | | | |
| Acute | 35.10 | Insectivore (small insects) | 12.31 | 0.38 | 1.35 | 0.04 | 6.86 | 0.21 | 0.76 | 0.02 |
| | 35.10 | Granivore (grain and seeds) | 3.08 | 0.1 | 0.34 | 0.01 | 1.47 | 0.05 | 0.16 | 0.01 |
| | 35.10 | Frugivore (fruit) | 6.15 | 0.19 | 0.68 | 0.02 | 2.94 | 0.09 | 0.32 | 0.01 |
| Reproduction | 50.00 | Insectivore(small insects) | 12.31 | 0.25 | 1.35 | 0.03 | 6.86 | 0.14 | 0.76 | 0.02 |
| | 50.00 | Granivore (grain and seeds) | 3.08 | 0.06 | 0.34 | 0.01 | 1.47 | 0.03 | 0.16 | 0.003 |
| | 50.00 | Frugivore (fruit) | 6.15 | 0.12 | 0.68 | 0.01 | 2.94 | 0.06 | 0.32 | 0.007 |
| **Medium Sized Mammal (0.035 kg)** | | | | | | | | | | |
| Acute | 35.10 | Insectivore (small insects) | 28.03 | 0.8 | 3.08 | 0.09 | 15.63 | 0.45 | 1.72 | 0.05 |

| | | | Maximum nomogram residues | | | | Mean nomogram residues | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On-field | | Off-field | | On-field | | Off-field | |
| | Toxicity (mg a.i./kg bw/d) | Food Guild (food item) | EDE (mg a.i./kg bw) | RQ | EDE (mg a.i./kg bw) | RQ | EDE (mg a.i./kg bw) | RQ | EDE (mg a.i./kg bw) | RQ |
| | 35.10 | Insectivore (large insects) | 7.01 | 0.2 | 0.77 | 0.02 | 3.34 | 0.1 | 0.37 | 0.01 |
| | 35.10 | Granivore (grain and seeds) | 7.01 | 0.2 | 0.77 | 0.02 | 3.34 | 0.1 | 0.37 | 0.01 |
| | 35.10 | Frugivore (fruit) | 14.02 | 0.4 | 1.54 | 0.04 | 6.68 | 0.19 | 0.74 | 0.02 |
| | 35.10 | Herbivore (short grass) | 100.18 | 2.85 | 11.02 | 0.31 | 35.58 | 1.01 | 3.91 | 0.11 |
| | 35.10 | Herbivore (long grass) | 61.17 | 1.74 | 6.73 | 0.19 | 19.97 | 0.57 | 2.20 | 0.06 |
| | 35.10 | Herbivore (forage crops) | 92.69 | 2.64 | 10.20 | 0.29 | 30.64 | 0.87 | 3.37 | 0.1 |
| | 35.10 | Herbivore (leafy foliage) | 188.81 | 5.38 | 20.77 | 0.59 | 62.42 | 1.78 | 6.87 | 0.2 |
| Reproduction | 50.00 | Insectivore (small insects) | 28.03 | 0.56 | 3.08 | 0.06 | 15.63 | 0.31 | 1.72 | 0.03 |
| | 50.00 | Insectivore (large insects) | 7.01 | 0.14 | 0.77 | 0.02 | 3.34 | 0.07 | 0.37 | 0.01 |
| | 50.00 | Granivore (grain and seeds) | 7.01 | 0.14 | 0.77 | 0.02 | 3.34 | 0.07 | 0.37 | 0.01 |
| | 50.00 | Frugivore (fruit) | 14.02 | 0.28 | 1.54 | 0.03 | 6.68 | 0.13 | 0.74 | 0.02 |
| | 50.00 | Herbivore (short grass) | 100.18 | 2.00 | 11.02 | 0.22 | 35.58 | 0.71 | 3.91 | 0.08 |
| | 50.00 | Herbivore (long grass) | 61.17 | 1.22 | 6.73 | 0.13 | 19.97 | 0.4 | 2.20 | 0.04 |
| | 50.00 | Herbivore (forage crops) | 92.69 | 1.85 | 10.20 | 0.20 | 30.64 | 0.61 | 3.37 | 0.07 |
| | 50.00 | Herbivore (leafy foliage) | 188.81 | 3.78 | 20.77 | 0.412 | 62.42 | 1.25 | 6.87 | 0.14 |
| **Large Sized Mammal (1 kg)** | | | | | | | | | | |
| Acute | 35.10 | Insectivore (small insects) | 14.98 | 0.43 | 1.65 | 0.05 | 8.35 | 0.24 | 0.92 | 0.03 |
| | 35.10 | Insectivore (large insects) | 3.74 | 0.11 | 0.41 | 0.01 | 1.79 | 0.05 | 0.20 | 0.01 |
| | 35.10 | Granivore (grain and seeds) | 3.74 | 0.11 | 0.41 | 0.01 | 1.79 | 0.05 | 0.20 | 0.01 |
| | 35.10 | Frugivore (fruit) | 7.49 | 0.21 | 0.82 | 0.02 | 3.57 | 0.10 | 0.39 | 0.01 |
| | 35.10 | Herbivore (short grass) | 53.53 | 1.53 | 5.89 | 0.17 | 19.01 | 0.54 | 2.09 | 0.06 |
| | 35.10 | Herbivore (long grass) | 32.68 | 0.93 | 3.60 | 0.10 | 10.67 | 0.30 | 1.17 | 0.03 |
| | 35.10 | Herbivore (forage crops) | 49.53 | 1.41 | 5.45 | 0.16 | 16.37 | 0.47 | 1.80 | 0.05 |
| | 35.10 | Herbivore (leafy foliage) | 100.89 | 2.87 | 11.10 | 0.31 | 33.35 | 0.95 | 3.67 | 0.10 |
| Reproduction | 50.00 | Insectivore (small insects) | 14.98 | 0.3 | 1.65 | 0.03 | 8.35 | 0.17 | 0.92 | 0.02 |
| | 50.00 | Insectivore (large insects) | 3.74 | 0.07 | 0.41 | 0.01 | 1.79 | 0.04 | 0.20 | 0.004 |
| | 50.00 | Granivore (grain and seeds) | 3.74 | 0.07 | 0.41 | 0.01 | 1.79 | 0.04 | 0.20 | 0.004 |
| | 50.00 | Frugivore (fruit) | 7.49 | 0.15 | 0.82 | 0.02 | 3.57 | 0.07 | 0.39 | 0.008 |
| | 50.00 | Herbivore (short grass) | 53.53 | 1.07 | 5.89 | 0.12 | 19.01 | 0.38 | 2.09 | 0.04 |
| | 50.00 | Herbivore (long grass) | 32.68 | 0.65 | 3.60 | 0.07 | 10.67 | 0.21 | 1.17 | 0.02 |
| | 50.00 | Herbivore (forage crops) | 49.53 | 0.99 | 5.45 | 0.11 | 16.37 | 0.33 | 1.80 | 0.04 |
| | 50.00 | Herbivore (leafy foliage) | 100.89 | 2.02 | 11.10 | 0.22 | 33.35 | 0.67 | 3.67 | 0.07 |

[1] Based on cumulative rate of 1.103 kg a.i./ha (4 applic.@852 g a.i./ha with 7d interval)

Shaded cells indicates exceedance of LOC.

## Table 9 Methamidophos Risk Assessment for Birds[1]

| | | | Maximum nomogram residues | | | | Mean nomogram residues | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On-field | | Off-field | | On-field | | Off-field | |
| | Toxicity (mg a.i./kg bw/d) | Food Guild (food item) | EDE (mg a.i./kg bw) | RQ | EDE (mg a.i./kg bw) | RQ | EDE (mg a.i./kg bw) | RQ | EDE (mg a.i./kg bw) | RQ |
| **Small Bird (0.02 kg)** | | | | | | | | | | |
| Acute | 0.80 | Insectivore (small insects) | 21.40 | 26.75 | 2.35 | 2.94 | 11.94 | 14.92 | 1.31 | 1.64 |
| | 0.80 | Granivore (grain and seeds) | 5.35 | 6.69 | 0.59 | 0.74 | 2.55 | 3.19 | 0.28 | 0.35 |
| | 0.80 | Frugivore (fruit) | 10.70 | 13.38 | 1.18 | 1.47 | 5.10 | 6.38 | 0.56 | 0.70 |
| Dietary | 4.20 | Insectivore (small insects) | 21.40 | 5.10 | 2.35 | 0.56 | 11.94 | 2.84 | 1.31 | 0.31 |
| | 4.20 | Granivore (grain and seeds) | 5.35 | 1.27 | 0.59 | 0.14 | 2.55 | 0.61 | 0.28 | 0.07 |
| | 4.20 | Frugivore (fruit) | 10.70 | 2.55 | 1.18 | 0.28 | 5.10 | 1.22 | 0.56 | 0.13 |
| Reproduction | 3.00 | Insectivore (small insects) | 21.40 | 7.13 | 2.35 | 0.78 | 11.94 | 3.98 | 1.31 | 0.44 |
| | 3.00 | Granivore (grain and seeds) | 5.35 | 1.78 | 0.59 | 0.20 | 2.55 | 0.85 | 0.28 | 0.09 |
| | 3.00 | Frugivore (fruit) | 10.70 | 3.57 | 1.18 | 0.39 | 5.10 | 1.70 | 0.56 | 0.19 |
| **Medium Sized Bird (0.1 kg)** | | | | | | | | | | |
| Acute | 0.80 | Insectivore (small insects) | 16.70 | 20.88 | 1.84 | 2.30 | 9.31 | 11.64 | 1.02 | 1.28 |
| | 0.80 | Insectivore (large insects) | 4.18 | 5.22 | 0.46 | 0.57 | 1.99 | 2.49 | 0.22 | 0.27 |
| | 0.80 | Granivore (grain and seeds) | 4.18 | 5.22 | 0.46 | 0.57 | 1.99 | 2.49 | 0.22 | 0.27 |
| | 0.80 | Frugivore (fruit) | 8.35 | 10.44 | 0.92 | 1.15 | 3.98 | 4.98 | 0.44 | 0.55 |
| Dietary | 4.20 | Insectivore (small insects) | 16.70 | 3.98 | 1.84 | 0.44 | 9.31 | 2.22 | 1.02 | 0.24 |
| | 4.20 | Insectivore (large insects) | 4.18 | 0.99 | 0.46 | 0.11 | 1.99 | 0.47 | 0.22 | 0.05 |
| | 4.20 | Granivore (grain and seeds) | 4.18 | 0.99 | 0.46 | 0.11 | 1.99 | 0.47 | 0.22 | 0.05 |
| | 4.20 | Frugivore (fruit) | 8.35 | 1.99 | 0.92 | 0.22 | 3.98 | 0.95 | 0.44 | 0.10 |
| Reproduction | 3.00 | Insectivore (small insects) | 16.70 | 5.57 | 1.84 | 0.61 | 9.31 | 3.10 | 1.02 | 0.34 |
| | 3.00 | Insectivore (large insects) | 4.18 | 1.39 | 0.46 | 0.15 | 1.99 | 0.66 | 0.22 | 0.07 |
| | 3.00 | Granivore (grain and seeds) | 4.18 | 1.39 | 0.46 | 0.15 | 1.99 | 0.66 | 0.22 | 0.07 |
| | 3.00 | Frugivore (fruit) | 8.35 | 2.78 | 0.92 | 0.31 | 3.98 | 1.33 | 0.44 | 0.15 |
| **Large Sized Bird (1 kg)** | | | | | | | | | | |
| Acute | 0.80 | Insectivore (small insects) | 4.88 | 6.10 | 0.54 | 0.67 | 2.72 | 3.40 | 0.30 | 0.37 |
| | 0.80 | Insectivore (large insects) | 1.22 | 1.52 | 0.13 | 0.17 | 0.58 | 0.73 | 0.06 | 0.08 |
| | 0.80 | Granivore (grain and seeds) | 1.22 | 1.52 | 0.13 | 0.17 | 0.58 | 0.73 | 0.06 | 0.08 |
| | 0.80 | Frugivore (fruit) | 2.44 | 3.05 | 0.27 | 0.34 | 1.16 | 1.45 | 0.13 | 0.16 |
| | 0.80 | Herbivore (short grass) | 17.43 | 21.78 | 1.92 | 2.40 | 6.19 | 7.74 | 0.68 | 0.85 |
| | 0.80 | Herbivore (long grass) | 10.64 | 13.30 | 1.17 | 1.46 | 3.47 | 4.34 | 0.38 | 0.48 |
| | 0.80 | Herbivore (forage crops) | 16.12 | 20.16 | 1.77 | 2.22 | 5.33 | 6.66 | 0.59 | 0.73 |

| | | | Maximum nomogram residues | | | | Mean nomogram residues | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On-field | | Off-field | | On-field | | Off-field | |
| | Toxicity (mg a.i./kg bw/d) | Food Guild (food item) | EDE (mg a.i./kg bw) | RQ | EDE (mg a.i./kg bw) | RQ | EDE (mg a.i./kg bw) | RQ | EDE (mg a.i./kg bw) | RQ |
| Dietary | 4.20 | Insectivore (small insects) | 4.88 | 1.16 | 0.54 | 0.13 | 2.72 | 0.65 | 0.30 | 0.07 |
| | 4.20 | Insectivore (large insects) | 1.22 | 0.29 | 0.13 | 0.03 | 0.58 | 0.14 | 0.06 | 0.02 |
| | 4.20 | Granivore (grain and seeds) | 1.22 | 0.29 | 0.13 | 0.03 | 0.58 | 0.14 | 0.06 | 0.02 |
| | 4.20 | Frugivore (fruit) | 2.44 | 0.58 | 0.27 | 0.06 | 1.16 | 0.28 | 0.13 | 0.03 |
| | 4.20 | Herbivore (short grass) | 17.43 | 4.15 | 1.92 | 0.46 | 6.19 | 1.47 | 0.68 | 0.16 |
| | 4.20 | Herbivore (long grass) | 10.64 | 2.53 | 1.17 | 0.28 | 3.47 | 0.83 | 0.38 | 0.09 |
| | 4.20 | Herbivore (forage crops) | 16.12 | 3.84 | 1.77 | 0.42 | 5.33 | 1.27 | 0.59 | 0.14 |
| Reproduction | 3.00 | Insectivore (small insects) | 4.88 | 1.63 | 0.54 | 0.18 | 2.72 | 0.91 | 0.30 | 0.10 |
| | 3.00 | Insectivore (large insects) | 1.22 | 0.41 | 0.13 | 0.04 | 0.58 | 0.19 | 0.06 | 0.02 |
| | 3.00 | Granivore (grain and seeds) | 1.22 | 0.41 | 0.13 | 0.04 | 0.58 | 0.19 | 0.06 | 0.02 |
| | 3.00 | Frugivore (fruit) | 2.44 | 0.81 | 0.27 | 0.09 | 1.16 | 0.39 | 0.13 | 0.04 |
| | 3.00 | Herbivore (short grass) | 17.43 | 5.81 | 1.92 | 0.64 | 6.19 | 2.06 | 0.68 | 0.23 |
| | 3.00 | Herbivore (long grass) | 10.64 | 3.55 | 1.17 | 0.39 | 3.47 | 1.16 | 0.38 | 0.13 |
| | 3.00 | Herbivore (forage crops) | 16.12 | 5.37 | 1.77 | 0.59 | 5.33 | 1.78 | 0.59 | 0.20 |

[1] Based on cumulative application rate of 424.7 g a.i./ha (4 applic. @ 328 g a.i./ha with 7d interval)

Shaded cells indicates exceedance of LOC.

## Table 10 Methamidophos Risk Assessment for Mammals[1]

| | | | Maximum nomogram residues | | | | Mean nomogram residues | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On-field | | Off-field | | On-field | | Off-field | |
| | Toxicity (mg a.i./kg bw/d) | Food Guild (food item) | EDE (mg a.i./kg bw) | RQ | EDE (mg a.i./kg bw) | RQ | EDE (mg a.i./kg bw) | RQ | EDE (mg a.i./kg bw) | RQ |
| Small Mammal (0.015 kg) | | | | | | | | | | |
| Acute | 1.30 | Insectivore (small insects) | 12.31 | 9.47 | 1.35 | 1.04 | 6.86 | 5.28 | 0.76 | 0.58 |
| | 1.30 | Granivore (grain and seeds) | 3.08 | 2.37 | 0.34 | 0.26 | 1.47 | 1.13 | 0.16 | 0.12 |
| | 1.30 | Frugivore (fruit) | 6.15 | 4.73 | 0.68 | 0.52 | 2.94 | 2.26 | 0.32 | 0.25 |
| Reproduction | 10.00 | Insectivore(small insects) | 12.31 | 1.23 | 1.35 | 0.14 | 6.86 | 0.69 | 0.76 | 0.08 |
| | 10.00 | Granivore (grain and seeds) | 3.08 | 0.31 | 0.34 | 0.03 | 1.47 | 0.15 | 0.16 | 0.02 |
| | 10.00 | Frugivore (fruit) | 6.15 | 0.62 | 0.68 | 0.07 | 2.94 | 0.29 | 0.32 | 0.03 |
| Medium Sized Mammal (0.035 kg) | | | | | | | | | | |
| Acute | 1.30 | Insectivore (small insects) | 10.79 | 8.30 | 1.19 | 0.91 | 6.02 | 4.63 | 0.66 | 0.51 |

| | | | Maximum nomogram residues | | | | Mean nomogram residues | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On-field | | Off-field | | On-field | | Off-field | |
| | Toxicity (mg a.i./kg bw/d) | Food Guild (food item) | EDE (mg a.i./kg bw) | RQ | EDE (mg a.i./kg bw) | RQ | EDE (mg a.i./kg bw) | RQ | EDE (mg a.i./kg bw) | RQ |
| | 1.30 | Insectivore (large insects) | 2.70 | 2.08 | 0.30 | 0.23 | 1.29 | 0.99 | 0.14 | 0.11 |
| | 1.30 | Granivore (grain and seeds) | 2.70 | 2.08 | 0.30 | 0.23 | 1.29 | 0.99 | 0.14 | 0.11 |
| | 1.30 | Frugivore (fruit) | 5.40 | 4.15 | 0.59 | 0.46 | 2.57 | 1.98 | 0.28 | 0.22 |
| | 1.30 | Herbivore (short grass) | 38.57 | 29.67 | 4.24 | 3.26 | 13.70 | 10.54 | 1.51 | 1.16 |
| | 1.30 | Herbivore (long grass) | 23.55 | 18.11 | 2.59 | 1.99 | 7.69 | 5.91 | 0.85 | 0.65 |
| | 1.30 | Herbivore (forage crops) | 35.68 | 27.45 | 3.93 | 3.02 | 11.80 | 9.07 | 1.30 | 0.99 |
| | 1.30 | Herbivore (leafy foliage) | 72.69 | 55.91 | 8.00 | 6.15 | 24.03 | 18.48 | 2.64 | 2.03 |
| Reproduction | 10.00 | Insectivore (small insects) | 10.79 | 1.08 | 1.19 | 0.12 | 6.02 | 0.60 | 0.66 | 0.07 |
| | 10.00 | Insectivore (large insects) | 2.70 | 0.27 | 0.30 | 0.03 | 1.29 | 0.13 | 0.14 | 0.01 |
| | 10.00 | Granivore (grain and seeds) | 2.70 | 0.27 | 0.30 | 0.03 | 1.29 | 0.13 | 0.14 | 0.01 |
| | 10.00 | Frugivore (fruit) | 5.40 | 0.54 | 0.59 | 0.06 | 2.57 | 0.26 | 0.28 | 0.03 |
| | 10.00 | Herbivore (short grass) | 38.57 | 3.86 | 4.24 | 0.42 | 13.70 | 1.37 | 1.51 | 0.15 |
| | 10.00 | Herbivore (long grass) | 23.55 | 2.35 | 2.59 | 0.26 | 7.69 | 0.77 | 0.85 | 0.08 |
| | 10.00 | Herbivore (forage crops) | 35.68 | 3.57 | 3.93 | 0.39 | 11.80 | 1.18 | 1.30 | 0.13 |
| | 10.00 | Herbivore (leafy foliage) | 72.69 | 7.27 | 8.00 | 0.8 | 24.03 | 2.40 | 2.64 | 0.26 |
| **Large Sized Mammal (1 kg)** | | | | | | | | | | |
| Acute | 1.30 | Insectivore (small insects) | 5.77 | 4.44 | 0.63 | 0.49 | 3.22 | 2.47 | 0.35 | 0.27 |
| | 1.30 | Insectivore (large insects) | 1.44 | 1.11 | 0.16 | 0.12 | 0.69 | 0.53 | 0.08 | 0.06 |
| | 1.30 | Granivore (grain and seeds) | 1.44 | 1.11 | 0.16 | 0.12 | 0.69 | 0.53 | 0.08 | 0.06 |
| | 1.30 | Frugivore (fruit) | 2.88 | 2.22 | 0.32 | 0.24 | 1.37 | 1.06 | 0.15 | 0.12 |
| | 1.30 | Herbivore (short grass) | 20.61 | 15.85 | 2.27 | 1.74 | 7.32 | 5.63 | 0.81 | 0.62 |
| | 1.30 | Herbivore (long grass) | 12.58 | 9.68 | 1.38 | 1.06 | 4.11 | 3.16 | 0.45 | 0.35 |
| | 1.30 | Herbivore (forage crops) | 19.07 | 14.67 | 2.10 | 1.61 | 6.30 | 4.85 | 0.69 | 0.53 |
| | 1.30 | Herbivore (leafy foliage) | 38.84 | 29.88 | 4.27 | 3.29 | 12.84 | 9.88 | 1.41 | 1.09 |
| Reproduction | 10.00 | Insectivore (small insects) | 5.77 | 0.58 | 0.63 | 0.06 | 3.22 | 0.32 | 0.35 | 0.04 |
| | 10.00 | Insectivore (large insects) | 1.44 | 0.14 | 0.16 | 0.02 | 0.69 | 0.07 | 0.08 | 0.01 |
| | 10.00 | Granivore (grain and seeds) | 1.44 | 0.14 | 0.16 | 0.02 | 0.69 | 0.07 | 0.08 | 0.01 |
| | 10.00 | Frugivore (fruit) | 2.88 | 0.29 | 0.32 | 0.03 | 1.37 | 0.14 | 0.15 | 0.02 |
| | 10.00 | Herbivore (short grass) | 20.61 | 2.06 | 2.27 | 0.23 | 7.32 | 0.73 | 0.81 | 0.08 |
| | 10.00 | Herbivore (long grass) | 12.58 | 1.26 | 1.38 | 0.14 | 4.11 | 0.41 | 0.45 | 0.05 |
| | 10.00 | Herbivore (forage crops) | 19.07 | 1.91 | 2.10 | 0.21 | 6.30 | 0.63 | 0.69 | 0.07 |
| | 10.00 | Herbivore (leafy foliage) | 38.84 | 3.88 | 4.27 | 0.43 | 12.84 | 1.28 | 1.41 | 0.14 |

[1] Based on cumulative application rate of 424.7 g a.i./ha (4 applic. @ 328 g a.i./ha with 7d interval)

Shaded cells indicates exceedance of LOC.

**Table 11 Toxic Substances Management Policy Considerations-Comparison to TSMP Track 1 Criteria**

| TSMP Track 1 Criteria | TSMP Track 1 Criterion value | | Active Ingredient Endpoints (Acephate) | Transformation Product Endpoints (Methamidophos) |
|---|---|---|---|---|
| CEPA toxic or CEPA toxic equivalent[1] | Yes | | - | Yes |
| Predominantly anthropogenic[2] | Yes | | - | Yes |
| Persistence[3]: | Soil | Half-life ≥ 182 days | Half-life = 2 d | Half-life = 0.5-36 d |
| | Water | Half-life ≥ 182 days | Half-life = 7 | Half-life = 5.8 d |
| | Sediment | Half-life ≥ 365 days | not available | Half-life = 4.1 (water/sediment) |
| | Air | Half-life ≥ 2 days or evidence of long range transport | Half-life or volatilisation is not an important route of dissipation and long-range atmospheric transport is unlikely to occur based on the vapour pressure ($2.26\times10^{-4}$Pa) and Henry's law constant ($4.9\text{x}10^{-13}$ atm·m$^3$·mole$^{-1}$). | Half-life or volatilisation is not an important route of dissipation and long-range atmospheric transport is unlikely to occur based on the vapour pressure ($2.29\times10^{-8}$Pa) and Henry's law constant ($1.6\text{x}10^{-11}$ atm·m$^3$·mole$^{-1}$). |
| Bioaccumulation[4] | Log $K_{OW} \geq 5$ | | Log $K_{OW}$ = -0.9 | Log $K_{OW}$ = -0.796 |
| | BCF ≥ 5000 | | not available | not available |
| | BAF ≥ 5000 | | not available | not available |
| Is the chemical a TSMP Track 1 substance (all four criteria must be met)? | | | No, does not meet TSMP Track 1 criteria. | No, does not meet TSMP Track 1 criteria. |

[1] All pesticides will be considered CEPA-toxic or CEPA toxic equivalent for the purpose of initially assessing a pesticide against the TSMP criteria. Assessment of the CEPA toxicity criteria may be refined if required (for example, all other TSMP criteria are met).

[2] The policy considers a substance "predominantly anthropogenic" if, based on expert judgment, its concentration in the environment medium is largely due to human activity, rather than to natural sources or releases.

[3] If the pesticide and/or the transformation product(s) meet one persistence criterion identified for one media (soil, water, sediment or air) than the criterion for persistence is considered to be met.

[4] Field data (for example, BAFs) are preferred over laboratory data (for example, BCFs) which, in turn, are preferred over chemical properties (for example, log $K_{OW}$).

# Appendix X Monitoring Data

## Water Monitoring Data

A search for Canadian acephate water monitoring data revealed that routine analysis for acephate is not conducted. The limited monitoring data available in the United States combined with the lack of monitoring data within Canada did not allow for an estimation of acephate residues in potential drinking water sources to be calculated through statistical analysis of monitoring data. At this time, therefore, the drinking water values used in the exposure risk assessment were estimated by modelling.

**Table 1 Summary of Water Modelling Input Parameters, Level 2 Assessment of acephate and methamidophos.**

| Item | Value |
|---|---|
| Product type | insecticide |
| Use site category | 13, 14 |
| Crops to be treated | Brussels sprouts, Cabbage, Cauliflower, Celery, Corn (sweet and seed), Cranberries, Lettuce (head & leaf), Peppers, Potatoes, Saskatoon berries, Tobacco, Tomatoes |
| Crops using the maximum label rate | Celery, Corn (sweet and seed), lettuce (head & leaf), Peppers, Potatoes |
| Geographic area(s) for registration | All |
| Maximum allowable rate per year (g a.i./ha) | 3300 |
| Maximum allowable rate at each application (g a.i./ha), if multiple applications | 825 |
| Maximum number of applications per year | 4 |
| Minimum interval between application (d) | 5 to 7 |
| Timing of application (approximate dates) | Between May and August |

## Table 2 Level 2 Estimated Environmental Concentrations of Acephate and Methamidophos in Potential Drinking Water Source

| | Use pattern | Groundwater EEC (ug a.i./L) | | Surface Water EEC (ug a.i./L) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Reservoir | | Dugout | |
| | | Daily[1] | Yearly[2] | Daily[3] | Yearly[4] | Daily[3] | Yearly[4] |
| Acephate | Sweet corn and potato | 1.2 | 1.1 | 97 | 6.3 | 132 | 9.8 |
| Methamidophos | Sweet corn and potato | 0.46 | 0.38 | 32 | 1.7 | 42 | 21 |

[1] 90th percentile of daily average concentrations
[2] 90th percentile of yearly average concentrations
[3] 90th percentile of daily peak concentrations
[4] 90th percentile of yearly average concentrations

## Table 3 Refined Level 2 Estimated Environmental Concentrations of Acephate and Methamidophos in Potential Drinking Water Source

| | Use pattern | Groundwater EEC (ug a.i./L) | | Surface Water EEC (ug a.i./L) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Reservoir | | Dugout | |
| | | Daily[1] | Yearly[2] | Daily[3] | Yearly[4] | Daily[3] | Yearly[4] |
| Acephate | Refined bell pepper, sweet corn and head lettuce | NM | NM | 6.9 | 0.46 | NM | NM |
| Methamidophos | Refined bell pepper, sweet corn and head lettuce | NM | NM | 0.82 | 0.046 | NM | NM |

[1] 90th percentile of daily average concentrations
[2] 90th percentile of yearly average concentrations
[3] 90th percentile of daily peak concentrations
[4] 90th percentile of yearly average concentrations
NM - Not modelled

# Appendix XI Label Amendments for Commercial Class Products Containing Acephate

Note: The label amendments presented below do not include all label requirements for individual end-use products, such as first aid statements, disposal statements, precautionary statements and supplementary protective equipment. Additional information on labels of currently registered products should not be removed unless it contradicts the label statements below.

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Please note the label statements below are presented in two sections: Label statements in section A are required for existing product labels; label statements in section B will be required if registrants apply to add uses currently on the label of soluble powder formulation (proposed to be cancelled) to the label of the pellet formulation.

A. The Following Label Statements are Required for All End-Use Products (Currently Formulated As Pellet and Cartridge Implants)**:**

## TOXICOLOGICAL INFORMATION

Based on the toxicological assessments, the label text of the acephate containing products should be expanded and/or standardized, as follows:

> **Toxicological Information**
> Acephate is an organophosphate that is a cholinesterase inhibitor. Typical symptoms of overexposure to cholinesterase inhibitors include headache, nausea, dizziness, sweating, salivation, runny nose and eyes. This may progress to muscle twitching, weakness, tremor, incoordination, vomiting, abdominal cramps and diarrhea in more serious poisonings. A life-threatening poisoning is signified by loss of consciousness, incontinence, convulsions and respiratory depression with a secondary cardiovascular component. Treat symptomatically. If exposed, plasma and red blood cell cholinesterase tests may indicate degree of exposure (baseline data are useful). Atropine, only by injection, is the preferable antidote. Oximes, such as pralidoxime chloride, may be therapeutic if used early; however, use only in conjunction with atropine. In cases of severe acute poisoning, use antidotes immediately after establishing an open airway and respiration. With oral exposure, the decision of whether to induce vomiting or not should be made by an attending physician.

## PRECAUTION STATEMENTS

The following label statements are proposed when product is applied as spray:

> This product cannot be applied as a foliar application in residential areas. Residential areas are defined as any use site where bystanders including children could be exposed during or after application. This includes homes, schools, public buildings or any other areas where the general public including children could be exposed.

Apply only when the potential for drift to areas of human habitation or areas of human activity such as houses, cottages, schools and recreational areas is minimal. Take into consideration wind speed, wind direction, temperature inversions, application equipment and sprayer settings.

## ENGINEERING CONTROLS AND PERSONAL PROTECTIVE EQUIPMENT:

Label statements must be amended (or added) to include the following directions as appropriate:

### Mixing and Loading:

When mixing and loading PELLET formulation:

Wear baseline PPE (long sleeved shirt and pants, shoes plus socks)

### Applying:

For PELLET formulation:

Wear baseline PPE (long sleeved shirt and pants, shoes plus socks).

For CARTRIDGE IMPLANTS:

Wear baseline PPE (long sleeved shirt and pants, shoes plus socks).

## DIRECTIONS FOR USE

## RESTRICTED-ENTRY INTERVAL:

| Crop | Activity | Proposed REI |
|---|---|---|
| Tobacco | Moving irrigation pipes by hand | 4 days |
| | All other activities | 12 hrs |

## ENVIRONMENTAL PRECAUTIONS:

The following label statements are required for PELLET formulation:

> **TOXIC** to bees. Bees may be exposed through direct spray, spray drift, and residues on/in leaves, pollen and nectar in flowering crops and weeds. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site. Avoid applications when bees are foraging in the treatment area in ground cover containing blooming weeds. To further minimize exposure to pollinators, refer to the complete guidance "Protecting Pollinators during Pesticide Spraying – Best Management Practices" on the Health Canada website (www.healthcanada.gc.ca/pollinators). Follow crop specific directions for application timing.

Avoid application during the crop blooming period. If applications must be made during the crop blooming period, restrict applications to evening when most bees are not foraging. When using managed bees for pollination services, DO NOT apply during the crop blooming period or during the 9 day period before the crop blooms.

**TOXIC** to birds, mammals and aquatic organisms. Observe buffer zones specified under DIRECTIONS FOR USE.

**Add to DIRECTIONS FOR USE:**

The following label statements are required for PELLET formulation:

To protect pollinators, follow the instructions regarding bees in the Environmental Precautions section. TOXIC to bees. Avoid application during the crop blooming period. If applications must be made during the crop blooming period, restrict applications to evening when most bees are not foraging. When using managed bees for pollination services, DO NOT apply during the crop blooming period or during the nine day period before the crop blooms.

To reduce runoff from treated areas into aquatic habitats avoid application to areas with a moderate to steep slope, compacted soil, or clay.

Avoid application when heavy rain is forecast.

Contamination of aquatic areas as a result of runoff may be reduced by including a vegetative strip between the treated area and the edge of the water body.

**Add to DIRECTIONS FOR USE:**

Field sprayer application: **DO NOT** apply during periods of dead calm. Avoid application of this product when winds are gusty. **DO NOT** apply with spray droplets smaller than the American Society of Agricultural Engineers (ASAE) fine classification. Boom height must be 60 cm or less above the crop or ground.

**DO NOT** apply by air.

**Buffer zones:**

Uses of the following spray methods or equipment **DO NOT** require a buffer zone: hand-held or backpack sprayer and spot treatment.

The buffer zones specified in the table below are required between the point of direct application and the closest downwind edge of sensitive freshwater habitats (such as lakes, rivers, sloughs, ponds, prairie potholes, creeks, marshes, streams, reservoirs and wetlands).

| Method of application | Crop | Buffer Zones (metres) Required for the Protection of: | |
|---|---|---|---|
| | | Freshwater Habitat of Depths: | |
| | | Less than 1 m | Greater than 1 m |
| Field sprayer | tobacco | 2 | 1 |

For tank mixes, consult the labels of the tank-mix partners and observe the largest (most restrictive) buffer zone of the products involved in the tank mixture and apply using the coarsest spray (ASAE) category indicated on the labels for those tank mix partners.

B. The Following Mitigation Measures Are Required if Registrants Apply to Add Uses Currently on the Label of Soluble Powder Formulation (proposed to be cancelled) to the Label for the Pellet Formulation

## ENGINEERING CONTROLS AND PERSONAL PROTECTIVE EQUIPMENT:

### Applying:

**For Mechanically Pressurized Handgun**
Wear baseline PPE (long sleeved shirt and pants, shoes plus socks) and a respirator

## DIRECTIONS FOR USE

Handheld mist blowers for indoor greenhouse use are prohibited

Foggers for indoor greenhouse use are prohibited.

For tomatoes, peppers, and lettuce, the following statement is required:
For outdoor use only.

Not for use on cut flowers (add this statement wherever directions for ornamentals are indicated).

Potato and cut flowers: Remove all use directions related to these uses

### Number of Applications:

Consult Table 1 below for the number of applications and application intervals per crop.

**Table 1 Maximum Rate, Maximum Number of Applications per Year and Minimum Application Intervals**

| Crop | Maximum Rate (kg a.i./ha | Maximum Number of applications per Year | Minimum Application Interval (days) |
|---|---|---|---|
| Bell Peppers | 0.56 | 2 | 14 |
| Brussels Sprouts | 0.56 | 2 | 14 |
| Cabbage | 0.56 | 2 | 14 |
| Cauliflower | 0.56 | 2 | 14 |
| Head Lettuce | 0.56 | 2 | 14 |
| Celery | 0.56 | 2 | 14 |
| Sweet Corn | 0.56 | 2 | 14 |
| Seed Corn | 0.56 | 2 | 14 |

## RESTRICTED-ENTRY INTERVAL

**Table 2 Restricted-Entry Intervals**

| Crop | Activity | PHI (days) | Proposed REI |
|---|---|---|---|
| Cauliflower, Brussels Sprouts, Cabbage | All activities | 28 | 12 hrs |
| Celery | All activities | 21 | 12 hrs |
| Head Lettuce, Bell Peppers | All activities | 7 | 12 hrs |
| Cranberries | Hand harvesting-raking, scouting | Not stated | 6 days |
| | All other activities | | 12 hrs |
| Seed corn | Hand detasseling | n/a | 20 days |
| | All other activities | | 12 hrs |
| Sweet corn | Hand harvesting | 21 | 20 days |
| | All other activities | | 12 hrs |
| Tomatoes | All activities | n/a | 12 hrs |
| Ornamentals (outdoors) | Moving irrigation pipes by hand | n/a | 19 days |
| | All other activities | | 12 hrs |
| Trees (coniferous and Deciduous)<br>Foliar application | Moving irrigation pipes by hand | n/a | 15 days |
| | Harvesting (Christmas trees) | | 13 days |
| | Scouting, shaping, hand pruning | | 5 days |
| | All other activities | | 12 hrs |
| Trees (implant cartridge or other injection | All activities | n/a | 12 hrs |

| Crop | Activity | PHI (days) | Proposed REI |
|---|---|---|---|
| techniques) | | | |
| Greenhouse ornamentals + nursery plants | All activities | n/a | 12 hrs |

n/a: not applicable

**ENVIRONMENTAL PRECAUTIONS**:

For applications on crops that are highly attractive to pollinators (cranberry and outdoor ornamentals excluding coniferous evergreens), or when using managed bees for pollination services:

> DO NOT apply during the crop blooming period or during the 9-day period before the crop blooms.

**Add to DIRECTIONS FOR USE:**

For cranberry and outdoor ornamentals excluding coniferous evergreens, include:

> TOXIC to bees. DO NOT apply during the crop blooming period or during the 9-day period before the crop blooms.

**Add to DIRECTIONS FOR USE:**

> Airblast application: **DO NOT** apply during periods of dead calm. Avoid application of this product when winds are gusty. **DO NOT** direct spray above plants to be treated. Turn off outward pointing nozzles at row ends and outer rows. **DO NOT** apply when wind speed is greater than 16 km/h at the application site as measured outside of the treatment area on the upwind side.

| Method of application | Crop | Buffer Zones (metres) Required for the Protection of: | |
|---|---|---|---|
| | | Freshwater Habitat of Depths: | |
| | | Less than 1 m | Greater than 1 m |
| Field sprayer | Cabbage, cauliflower, Brussels sprouts, head lettuce, celery, corn (seed and sweet), tomato, sweet pepper, cranberry, ornamentals, shade trees, Christmas tree plantations, farm woodlots, tree nurseries, shelter belts, rights-of-way, municipal parks | 2 | 1 |

| Method of application | Crop | | Buffer Zones (metres) Required for the Protection of: Freshwater Habitat of Depths: Less than 1 m | Buffer Zones (metres) Required for the Protection of: Freshwater Habitat of Depths: Greater than 1 m |
|---|---|---|---|---|
| Airblast | Ornamentals, shade trees, flowers (field grown), Christmas tree plantations, farm woodlots, tree nurseries, shelter belts, rights-of-way, municipal parks | Early growth stage | 5 | 2 |
| | | Late growth stage | 3 | 2 |

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| 1208135 | Dietary LC50 Study With Orthene Technical In Mallard Ducklings. Industrial Bio Test Laboratories, Inc. Project 8580-09327, September 13, 1976. Data Numbering Code: 9.6.2.4. |
| 1208137 | One-Generation Reproduction Study- Mallard Duck- Orthene Technical. Wildlife International Ltd., Project 162-107, December 5, 1979. Data Numbering Code: 9.6.3.1. |
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### Additional Information Considered

### Published Information

| PMRA Document Number | Reference |
|---|---|
| 2132434 | USEPA 1998 Reevaluation Decision Document (RED, EFED Chapter) for Acephate. |
| 2131251 | USEPA 2001. Interim Reevaluation Decision (IRED) Document for Acephate. |
| 2131268 | USEPA 2006. Reevaluation Decision (RED) Document for Acephate |
| 1658043 | USEPA 2002. Reevaluation Decision Document (RED, EFED Chapter) for Methamidophos. |
| 1658045 | USEPA 2006. Interim Reevaluation Decision (IRED) Document for Methamidophos.42 |
| 2406720 | Commission Decision of 25 March 2003 concerning the non-inclusion of acephate in Annex I to Council Directive 91/414/EEC and the withdrawal of authorisations for plant protection products containing this active substance. (2003/219/EC) |
| 2406780 | EUROPEAN COMMISSION Review report for the active substance acephate. 31 May 2002. SANCO/3057/99-final |
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